To John Smith codd Esq.— from Daniel Pring —

GENERAL

INDICATIONS,

WHICH RELATE TO

THE LAWS

OF THE

ORGANIC LIFE.

BY

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TO ALL THOSE,

WITH WHOM THE LOVE OF SCIENCE IS A PASSION,

INDEPENDENT OF PECUNIARY GAIN;

WHO HAVE SUFFICIENT ZEAL TO PURSUE IT

THROUGH ALL ITS INTRICACIES,

AND

SUFFICIENT PATIENCE TO SURMOUNT ITS DIFFICULTIES:

TO ALL THOSE

WHO PREFER TRUTH TO A SPLENDID EQUIPAGE

OR LUXURIOUS ENTERTAINMENTS:

The following Pages are,

WITH ALL POSSIBLE RESPECT,

Inscribed,

BY THEIR SINCERE FRIEND

AND MOST ZEALOUS ADMIRER,

AND VERY HUMBLE

AND OBEDIENT SERVANT,

THE AUTHOR.

Bath, December 15*th* 1819.

PREFACE.

To publish a work entirely speculative, appears to be a great innovation upon the fashion of philosophising, which prevails in these times. To those who take the present fashion for a model, or who cannot conceive any other mode of inquiring into physical subjects than by experiment, an abstract or speculative work must appear at least impertinent, if not absurd, or monstrous. Notwithstanding the severity of these charges, I have ventured to write, and to print such a book: not with the design of altering the present fashion, or of introducing a new one; but rather with the view of furnishing materials to the experimentalists, and of offering some additional suggestions, on a neglected department of inquiry, upon which their labours might be bestowed with apparent advantage.

To state more precisely the design of this volume, it is to trace, as far as may be done without the aid of new facts, the share which those properties have in the operations and phenomena of animal bodies, which are the causes of the distinction between the living and the dead states. With this view, the influence of these properties is spoken of in the principal relations in which it is liable to be exerted or to be considered. The influence of these properties will form a *distinct subject* of investigation in every process in which it is engaged. Such distinct investigation refers to a *complete development* of a single topic, or of any separate branch of the subject; and in this respect differs from my present design, which aspires to

shew only the *general agency* of these properties, and, as a consequence of this general agency, that no single process of an animal body can be fairly and fully investigated, without taking this agency into the account; nay, without making its exhibition a primary concern in the analysis of relations.

The work here proposed for the accomplishment of the experimentalists, is by no means new, or foreign to their habits: considerable progress has already been made in it; but if this progress can be facilitated by any additional suggestions, or by a more extended connection of the subject, the cause of science will be greatly served, and my present attempt will be amply rewarded.

The necessity and importance of the living principle in the phenomena of animals, has been remarked from the earliest periods of observation. That the Ancients were aware of the necessity of this principle, is proved by the fable of Promethens, who having formed a man of clay, stole fire from Heaven to animate him: in this fable the word "fire" is obviously an allegorical allusion to a principle of life. Since this earliest distinction between matter and life, the last has been variously noticed; and, until latter periods, has been rather a subject for fancy or imagination than one of philosophical inquiry, whether by experiment or induction. But, without excepting any period, the operations of this principle have been spoken of generally and vaguely, with but few exceptions, as will appear from a brief sketch of the light in which this principle has been hitherto regarded.

The first notice of the existence of a living principle, such as that suggested in the fable, assigned to it no precise importance and no particular influence. Many crude and fanciful conjectures were broached relative to an agency of life, and they appear to have been indulged in equally by poets and physicians. From one of the latter order, a theory subsequently arose which might more consistently have originated with the poets: according to this theory, that of Stahl, an *intelligent spirit* was said to animate bodies, and to direct

their operations with great method and design. This theory was too loose, too indiscriminate, to engage long a serious consideration. The fable of Prometheus shews that the influence of a living principle was esteemed necessary to the phenomena of life: the theory of Stahl assigned every thing to this principle: if it had assigned much, it would not have greatly erred; but in assigning any thing, it did not challenge implicit belief, because it was a fancy, and not an induction; or because the inference was not supported by the sort of evidence which philosophy requires. It strayed still further from sober truth, by proposing an *intelligent* principle, when the evidence upon the subject barely sanctioned the opinion of the existence of a principle of any sort, distinct from the material fabric.

Very little has since been added to the theory of Stahl concerning the general agency of a principle of life. The existence of the principle was insisted upon with some particularity by Mr. Hunter: and it was said by him, as by Stahl, that this principle was interested in all the operations of living bodies, which is almost reverting to the fable of Prometheus; for, if the mechanism of a man could not perform the operations of a living body, these operations must of course be attributed to the principle without which they could not be performed. The history of the affair thus far is simply this: the Ancients supposed the phenomena of animal bodies to be performed by a principle superadded to mechanism; Stahl endowed this principle with intelligence: Mr. Hunter adverts to the principle generally, as a principle of life, although in one function, that of the absorbents, he appears to fall completely into the theory of Stahl, by making these vessels little less than intelligent artificers. It is obvious that, up to this period, no great progress has been made in developing the nature or laws of the living principle; so loosely indeed has the subject altogether been remarked upon, that the opinions of men are still divided, whether the phenomena of the living state are to be referred to a principle of life, or whether they result merely from the material fabric.

The advocates on either side of this question respectively, assert, on the one hand, that life is produced by the co-operation of the corporeal functions; on the other, that life is not an effect of the material structure, but a principle superadded to it. Without designing to enter deeply into this dispute, it may be inquired, if life is a product of the functions, or of the mechanism, what makes the mechanism, or the functions? As the mechanism falls to decay, and as the functions cease, when life is extinct, it may be fairly presumed that life is instrumental to the formation and establishment of both. If it be said that the structures are formed, and the functions commenced, from a nucleus of peculiar construction, produced from a parental stock; I reply, that this is attributing more to construction or mechanism than is agreeable with analogy. We have no instance of a mechanism which can produce, or renovate itself, from its elements. Is the action of the heart, or the action of any other muscle, or is the secretion of urine by the kidneys, bile by the liver, mucus by the intestines, pus from raw surfaces, &c. to be explained by any resemblance which the construction of these organs bear to the known examples of mechanical arrangements which produce motion? At least, it is *incumbent* on those who would assert the affirmative, to shew by *what powers* in mechanics these animal movements, and these processes, are accomplished.

It must be confessed that there are in animals *peculiar* properties, which are concerned in their functions: if it be said that these are properties of the matter of which animals are composed, intending thereby a contradistinction to a superadded vital principle, the difference of opinion upon this question then becomes little more than verbal, to all the purposes of an investigation of the laws of these properties. To state the argument more concisely, it may be asserted by one party that the properties of life have no existence, except in connection with matter; and by the other party, that the properties of life had an existence distinct from matter, and are, in the form of a vital principle, superadded to matter.

On this, as on every question, it is proper that we should consult our experience; and appealing to this testimony, it must be decided that we have no proof of the existence of life in a form, capable of producing those phenomena from which its existence is inferred, except in connection with matter. In every stage of the existence of man, for example, beginning from the ovum as the first perceptible nucleus of his formation, our experience furnishes us with no proof of an independent existence of the properties of life, or an existence separate from matter. In this earliest stage, the future man consists of a few molecules, of no assignable arrangement, in connection with which are the properties which concur to the future development and functions of the animal. We certainly have no *experience* that these properties are superadded to a few particles in the ovarium, which previously existed without them, and received these properties subsequently to their own material aggregation. We have no *experience* of this; yet the circumstance may hereafter be made to appear, on other grounds, not improbable. Our experience upon the point is, that, in the first recognizable stage of the existence of an animal, properties of life, or disposing to the future functions which characterize life, are in connection with matter; and this connection endures as long as the characteristic phenomena of life continue to be displayed.

If it be asked, *can* the properties of life have a separate existence from matter? this question is to be discussed on other grounds than those which apply to the question, do the properties which accomplish the functions of life exist, except in connection with matter? With respect to the last question, our reply is that the phenomena of life are the result of a relation between certain properties and matter; that we have no *experience* of life, or of the existence of vital properties, except in connection with matter: this however may happen for the same reason that we have no *experience*, or but an equivocal one, of any thing else except in connection with matter, viz. that the senses with which we are furnished have a perceptive relation only with matter. But, in defect of ex-

perience, we rely upon our inferences, our confidence in which, as will hereafter appear, is sometimes very little less than that which is yielded to the objects of positive experience.

Descending then from the appeal to experience, it is to be inquired whether, upon the ground of analogy to our experience, we are furnished with any proof that the properties of life may exist independently of matter? Assuming the postulatum, which it is hereafter attempted to establish, that nothing which has an existence can cease to exist, the question may be thus answered: As the properties of life are real agents, as their agency is proved by their being the causes of certain effects which are imputed to them, it is to be inferred, in agreement with an universal law, that although these properties might change their form, *they cannot cease to exist.* During life, these properties, as they are consumed, either escape from the body or else pass into the structures. If the former, their existence then becomes separate or distinct from the organized matter: if the latter, as the structures must possess these properties at the time of death; as at this period not only the arrangement of the material fabric is broken up, but the substance itself will in time become gaseous, or cease to be matter; so, under either alternative, it appears that the properties of life may exist when they are no longer connected with a substance answering to the definition of matter. It appears that the organized substance, matter itself, might change its form, and cease to be material: and consequently, as the properties formerly in alliance with this matter continue to exist, their existence outlives their connection with matter. Leaving however these questions, in which I feel no great interest, it is proper here to make such apologies or explanations as the pages of this volume may appear to stand in need of, rather than to enter, in this place, upon the discussion of opinions which will not be found hereafter to have been totally overlooked.

It has been hinted that, whatever the order of the connection between life and the primitive material aggregation might have been, whether the ovum was first formed in the ovarium

and life afterwards bestowed upon it, or whether the life of the ovum originally inhered with the particles composing it; whichever of these alternatives is the true one is of no consequence with respect to an investigation of the laws of life, during those stages of existence in which life and matter are united, and concur in their phenomena. It is the object of this work to sketch an analysis of some phenomena which are produced by this co-operation. The terms employed to designate the department of life are "vital properties, properties of life, the vital principle, the principle of life, the organic spirit," &c. The two last only will require explanation. By "the principle of life" it is meant to designate the *collective* properties of life: some properties, or one property, of life, are terms which relate to an inferred analysis of the principle of life. By the "organic spirit" it is meant also to designate the collective, or aggregate, properties of life; and this term "spirit," which is almost obsolete, is chosen simply for the reason that it ought not to be rejected, or to have become obsolete, since this term serves as well as any other to distinguish inferred and invisible properties from those which are objects of the senses. This appears to be as much as is implied by the old distinction between matter and spirit; and my taste is sufficiently gothic to prefer an old term to a new one, when the old one has been disgraced without reason, and the new one is a mere innovation, or an affected improvement, without any real superiority.

It will be perceived that the preliminary chapters are the groundwork of the subsequent inquiry; that an application of the principles, laid down in these chapters, is constantly brought in aid of the development of the principal subject; and consequently these chapters could not have been omitted without the inconvenience of referring perpetually to doctrines which were no where distinctly stated. If it be said that these preliminary doctrines are pushed too far; that it would have been sufficient to have laid down the principles, and applied them merely to the subject of physiology; I reply, that their universality, upon which alone their credit is supported, would not have been thus physically demonstrated, and consequently

both the principles, and their application to the subject of physiology, would on this account have been liable to be questioned. Besides which, it is an honester part to shew the full extent of a doctrine, than to leave others to make their own application or construction of it; and I am the less diffident in doing this, in the present instance, because I feel a confidence that the cause which, by an ignorant or a superficial reader, may be supposed to be militated against by these doctrines, is, to the extent to which they apply, in reality served by them, as much as a cause can be served by placing it upon a true and solid, instead of a false or fanciful ground. In addition, it may be remarked that the vulgar are not likely to be interested or swayed by a discussion which will not fall in their way; and which, if it did, they would not understand. I would add, with respect to these preliminary chapters, that they were composed as much as four years since; and that the work has been several months in the press.

Another query might suggest itself to the reader, in perusing the following pages. How is it, it may be asked, that there is not in the whole book a single quotation, when it is so much the present fashion to publish books which contain little else but quotations? This question certainly places me in a very unlucky predicament. In justification of myself, however, I must observe, that I did intend to have made one or two quotations from Don Quixote; but it so happens, that, much as I reverence the authority of Cervantes, I had no occasion even for these. But although this custom of quotation has not in the work itself been treated with much respect, the deficiency may be thus made some amends for in the preface; where, indeed, I have great occasion for a reply to those who would ask why there are no quotations in my book, when works of fashion, and reputed erudition, are found to have three authorities, and sometimes five, at the bottom of every page? This very deficiency Cervantes himself thus pathetically laments: "Other authors can pass upon the public, by stuffing their books from Aristotle, Plato, and the whole company of ancient philosophers; thus amusing their readers into

a great opinion of their prodigious reading. Plutarch and Cicero are slurred upon the public for as orthodox doctors as St. Thomas or any of the Fathers. And then the method of these moderns is so wonderfully agreeable and full of variety, that they cannot fail to please. Now I want all these embellishments and graces: I have neither marginal notes nor critical remarks; I do not so much as know what authors I follow, and consequently can have no formal index 'of them,' as 'tis the fashion now, methodically strung on the letters of the alphabet, beginning with Aristotle, and ending with Zenophon, or Zoilus, or Zeuxis, which two last are commonly crammed into the same piece, though one of them was a famous painter and the other a saucy critic." Under which affliction Cervantes is thus consoled by his friend: "As to marginal notes and quotations from authors for your history, 'tis but dropping here and there some scattered Latin sentences that you have already by rote, or may have with little or no pains. These scraps of Latin will gain you the credit of a great grammarian, which, I'll assure you, is no small accomplishment in this age. And for the citation of so many authors, 'tis the easiest thing in nature: find out one of these books with an alphabetical index, and, without any farther ceremony, remove it *verbatim* into your own. There are fools enough to be thus drawn into an opinion of your work; at least such a flourishing train of attendants will give your book a fashionable air, and recommend it to sale."*

Taking leave of the authority of the great philosophical humourist, Cervantes, in objection to this plan of making books out of books, I will add a plain reason or two of my own; to wit, that, except in those systems which *profess* to comprise all that is already known on a subject, rather than to make any additions to it, there is no great advantage in multiplying the copies of books which have been before read under different names; that, generally speaking, the object of a book of science is to make some addition

* Vide Author's Preface to Don Quixote.—Ozell's edit.

to the subject of which it treats; and if an author has no more original thinking to impart than would fill a hand-bill, it is scarcely fair, in order to dispose of so small a commodity, to delude the public into the purchase of a whole book.

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GENERAL INDICATIONS,

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CHAP. I.—*Truth.*

§ 1. AS the word "Truth" is used in general, there is nothing further meant by it than that it is synonymous with "belief." Our religion is called the *true* religion: we esteem Christ to be above Mahomet: a Turk says his is the *true* religion, yet he conceives Mahomet to be greater than Christ. Another worships the Sun, a beast, or a devil of his own contrivance, and each is ready to affirm that his own is the *true* religion. Our notion of Truth certainly does not at first sight afford this latitude; it certainly does not allow that things contrary and incompatible can *both be true;* and yet it is seen, as in the above examples, that propositions which are contradictory may be respectively believed. If we want more examples, we have them in this way: a merchant hears that a great venture has miscarried; that his ship parted company in a tremendous sea, was speedily lost sight of, and was said to have gone down: this account seems well authenticated, and our merchant (as we are not apt to discredit ill) *believes* himself ruined, until he receives intelligence from his captain, saying how the ship rode through the tempest with slight damages, was then safe, and her cargo entire. The case is, that the merchant *believed* his ship lost, when *she was* safe. To proceed with fewer words—

§ 2. A question of Truth is a question of the *existence* of the object concerning which such question might be proposed. Truth then refers to existence, and may be applied universally as to the existence of the world, or, with limitation, reduced to any particular department or form of existence. To go a little higher, it must be inquired upon what foundation does our idea of existence

rest? and, how far are we to depend upon this notion? To answer these questions we must consider an example of that which we call *knowledge.**

§ 3. I *see* the candle which burns before me: in other words, I have a consciousness of the existence of such an object. Is there any further proof than *this consciousness* of its existence? If we are asked how we are assured, by such a reason, that the candle really does exist, what can we reply? Shall we say its existence is necessary to produce the idea? What tells us so? Why the impression which we already have; or our consciousness that it does exist. The only proof therefore which we have of the existence of externals, is the consciousness of their existence.

§ 4. Is it then *true* that an external exists? We must reply, that we have a consciousness of its existence; by which we mean that *it is true.* We cannot otherwise confirm the point, or establish it by higher proofs: for any additional reason which may be assigned to demonstrate its existence, must itself be founded upon this consciousness as its only evidence. For example: we cannot propose, as further proof, that if the candle did not exist, we should not be conscious of it; because this is assuming that it does exist upon the evidence of our consciousness. If, therefore, the consciousness of the existence of an object, is the only, and an adequate proof of its existence, it follows that all those objects of which we have a consciousness do exist.

§ 5. But this conclusion does not appear to correspond with our notion of *truth,* for a man in his *dreams* may have precisely the same consciousness as if he were in a theatre: his invention might supply the whole drama, and he might criticise the expression of the actors, the sentiments of the piece; he may be conscious of the presence of a friend to whom he communicates his remarks; he may be conscious of every thing that is false, as if it were a reality; and the only *truth* is that of which he is unconscious, viz. that the whole is the invention of his own mind. Or, a man in the clearest moonlight, when his senses are awake, may have the strongest perception of the figure of a relation who has been some time dead; a consciousness so unequivocal, as to agitate the functions of the organic life. It is to be presumed, that, upon recollection, a sensible man would impute this perception to a disordered state of his faculties, rather than believe in the reality of such a presence. This evidence of consciousness then, in order to prove an external, seems to be defective; or there appears to be an inconsistency in the credit which is to be assigned to it in different instances.

§ 6. To take an example of another kind: a man, with an incipient amaurosis, will say there are spots, motes, insects, or

* Throughout this chapter the kind of truth, or belief, referred to, is that relating to positive existences; and where this is not expressed it is to be understood, there is a truth, or belief, with respect to non-existence, which is subsequently spoken of.

cobwebs in the air; a man whose vision is, as we say, perfect, pronounces the atmosphere to be clear, and that there are no motes, insects, or cobwebs in it at all. Are there then spots, cobwebs, &c. in the air because our man with the disordered retina is *conscious of them*? We, who have the accustomed vision, say, no; but our evidence of the two is the weaker, it is that there are no motes, &c. in the air because we do *not* see them. Now if our testimony of the existence of an external be correct, viz. that we are conscious of the existence of such external (and we can cite no higher testimony), then it is also *true* that there are motes, &c. in the air, for their existence rests upon the same evidence which we admit, viz. that there is a consciousness of their existence.

§ 7. Thus then the difficulty stands: those things which we see, feel, hear, &c. are *true* respectively, because we are conscious of them; while there are also things, the cognizance of which belongs to the faculties of seeing, feeling, hearing, &c. and of which we *are also conscious*, but which are nevertheless *not true*. The real nature of truth cannot be altered by this apparent contradiction; for nothing can be plainer than that, if truth is consciousness, consciousness must be truth.

§ 8. But, it may be said, we suffer conviction, or consciousness, to be a test of truth only, in those instances in which such conviction is *immutable*. I ask again, what is the *proof* of truth in the immutable instances? It must still be replied, consciousness. Then if that of which we are conscious is true in one instance, why is it not true in another? The cases are identical; for if consciousness is truth, and there is no example of truth, which is not established by consciousness, how can we reject as false, that which is itself truth?

§ 9. It is said that conviction proves a truth only, when it is uniform or immutable with respect to the object. This distinction is generally allowed: but the distinction is an artificial one. The natural testimony of truth is consciousness, conviction, or belief; and that, in nature, must necessarily be always true, which we believe, or of the existence of which we are conscious. The artificial testimony of truth is founded upon the consent of mankind, by which truth itself, or consciousness, is sometimes rejected as false. Our present business is with natural truth.

§ 10. A man whose arm is paralyzed puts it into water of 130 degrees of heat, and he says the water is not warm: he immerses the other arm in the same water, and he is ready to affirm that it is hot. A person who has taken a dose of laudanum may wake in the night, and see the head of an ox between the curtains: he may recollect himself, and by the testimony of some other sense convince himself that he is awake; still he sees the head of the ox, his eyes fixed and flaming upon him: presently he sees the head recede gradually, and perhaps disappear. His *conviction* in this case was unequivocal; yet the next day he rejects this testimony

of consciousness, and considers the existence of such an object to have been *untrue*. To a person viewing objects through coloured glass, all things may appear green: a madman may address his plebeian friend as the Emperor of China, or as the Devil, or as Jupiter, as a fish, or a lion. The real objects in these cases giving rise to different convictions, are the same; our investigation of natural truth, or consciousness, requires that we should say why the same objects produce different convictions.

§ 11. The palsy of the arm does not affect the temperature of the water; the laudanum has no power to form such an external as a bullock's head; the disorder of the mind of the madman cannot convert a plebeian acquaintance into an emperor, a fish, &c.; the colour of the glass, through which objects are viewed, does not change the colour of the objects, &c. If then the same objects produce different convictions, it follows that the difference is in the constitution, or properties of the faculties, which are susceptible of the conviction, or in the medium through which this conviction is obtained. Hence it follows, further, that the consciousness of an existence is the result of a *relation* between the external world and the faculties by which we become acquainted with it; that the conviction is according to this relation; that if the object is changed, the consciousness of it will also be changed; that if the object is the same, but produces in different persons, or at different times, a different consciousness, that then it operates upon a different disposition of properties, or upon a different state of faculties. The consciousness then, or idea, which we have of an external is according to the nature of the external, and the state of the faculties, or of the intellectual constitution with which it is related.

§ 12. As consciousness is always the result of a relation, so the consciousness will always be according to the nature, or state of the constituents of the relation. If the external objects are the same, in relation with the same senses or faculties, they will produce the same convictions; but if the same external objects are related with other senses or faculties, they will produce different convictions. Now the *evidence*, so far as it respects truth or reality, is the same in every case; and consequently all consciousness, and therefore all truth, is relative. But it is agreed among mankind, that the only consciousness which shall be admitted as truth, is that which is produced by the operation of externals upon such a state or pre-disposition of the senses as is *general*, though not universal, among mankind. This is artificial truth, which is a limitation only of the natural truth, and being both produced in the same way, and resting upon precisely the same foundation, they are in nature of course both equally true. The difference between a madman who errs in his senses, and one of an otherwise diseased or defective sense, is that the consciousness of the madman is admitted without respect to artificial truth; that is, he does not acquiesce against his conviction in the truth which

is founded upon the consent of mankind, which consent arises out of a similar constitution or pre-disposition (and hence a similar relation with the same externals) of their faculties.

§ 13. If all truth is relative, it might be asked, what assurance have we that things are in reality such as we apprehend them? that our notions of the external world are correct? There is no other ground of this assurance than our own consciousness or belief. Truth is *immutable* when the constituents of the relation are the same; it changes when the constituents on either part are varied. If the senses of an individual are constituted differently from those of the rest of his species, his perceptions will be different from theirs. If the mind of an individual is elevated by genius or education very much above the level of the rest of his species, his opinions of what is *true* will be different from theirs. If the taste of an individual is highly cultivated, or peculiarly refined, he will pronounce things to be *bad* which others esteem *good*, and the contrary.

§ 14. Now if it be asked which of these contradictions is true, I reply, they are all true; they are all true in regard to those who entertain the respective convictions; but they are not all true with respect to the artificial standard, by which, in a general way, truth is decided by the majority which concur in the same belief. Yet this concurrence is so far from making out a standard by which truth becomes fixed and immutable, that the general belief of nations is many times changed, often reversed, in the course of civilization. This happens in matters of opinion, in taste, in our estimation of good and bad; and it would also happen in matters of sense, if the senses were liable to be changed by education, in the same manner as the understanding is changed. If the descendants of the present race for three generations should be destitute of the sense of hearing, they would be very apt to reject, according to the artificial standard, the truth of the existence of sounds; or if their senses should be so changed that they should be conscious only of some of the abstract, and not of the aggregate, properties of matter, the existence of the spiritual world would be adopted as true, and that of the material would be rejected as false.

§ 15. In all our attempts, in all our arguments to establish a truth, we aspire only to produce a conviction; and our appeal is successful or not according to the susceptibility of belief, in relation to the proofs which are designed to produce it. The same external objects operating upon, or in relation with, the same senses will produce the same convictions of truth and reality; the propositions which are believed as true by one, will be adopted as true by another, provided they are related with the same constitution of mind. If the senses are modified, the convictions in regard to the objects with which they are related, are also modified. If the mind is so disposed, it may reject the evidence of a *modified sense*, and conclude that it is false, because it is not the accustomed

impression, or because it does not agree with the consent of mankind, with regard to the same object. But if there is not this disposition of mind to belief, against the evidence of a modified sense, then, as in the madman, it is wholly trusted. We can in no instance cite a higher evidence for a truth than that we believe it; yet, often, that which we believed at one time, we find at another to be false. *These are two results, produced by two different relations:* the evidence for that which we now adopt, is precisely the evidence which we before had for that which is rejected.

§ 16. The nature then of truth is that it is an effect, the causes of which we can generally assign; and, like every other effect, it varies as its causes are modified. An external, in relation with our faculties, produces consciousness, or a belief of the existence of such external: change the external, and our consciousness is changed; let the external remain the same, but let, in matters of sense, our senses be modified, or, in matters of opinion, let our understanding be modified, and the same objects or the same arguments produce a different consciousness, or a different belief. The result of this relation is, that things, with the subjects of the relation, are what they appear; the results of investigation are an increase or substitution of matters of belief. The highest objects which we propose, by communicating the results of investigation, are to substitute fixed for wavering belief, and to make individual convictions acknowledged generally, or universally, as truths. If convictions, with regard to some objects, or propositions, are permanent, it is because, the objects remaining the same, the faculties with which they are related undergo no change.

§ 17. Truths or convictions may be variously divided: they may be divided into those which are uniform and constant, those which are liable to change, those which are sensible, those which are inferential, those which belong to the memory, those which are calculated to be popular, those which can be adopted only by a few, those which are entertained only by an individual, &c. My business is not with all these.

§ 18. Conviction, or belief, is sometimes positive, and sometimes mixed with doubt. Positive convictions are the effect of certain evidence so related with our senses or understanding, as to produce unequivocal belief. Belief mixed with doubt is the effect of another kind of evidence, so related with our senses or understandings as to produce only a degree of conviction. Accordingly, evidence is esteemed or depended upon in proportion to the conviction which it is capable of producing.

§ 19. The *evidence* of the reality or truth of externals is consciousness or conviction; and when we assert things as true, we affirm only our own consciousness or belief. The *evidence* which produces conviction, consists of the external objects, which, in matters of sense, are so related with our faculties that their existence is perceived; or in matters of reflection, of the

arguments, which are also so related as to produce physically, in the common way of cause and effect, partial convictions, or perhaps most commonly, belief mixed with doubt. The latter kind of evidence, viz. the means by which belief is produced, is not to be considered.

§ 20. We gain the belief of an existence either by the immediate operation of an external object upon our senses, or by a process of our own minds: the strength of evidence must always be proportionate to the strength of belief. In our examinations respecting the existence of things, our object is to improve our evidence, to substitute that which produces a certain for that which produces a doubtful conclusion. We can look for no higher satisfaction, with respect to things, than that we should possess with regard to them the most perfect belief; we can propose to ourselves no higher object of investigation.

§ 21. It may be objected that universal scepticism must be a consequence of this doctrine: for if, it may be urged, there is no other testimony of the existence of externals, but our belief of such existence; and if the strongest belief is liable, perhaps in rare instances, to be superseded by a different one; how, admitting this principle, can we feel assured of the reality of any thing beyond ourselves, or even of our own existence? I reply, such a doctrine does not lead to scepticism, but quite the reverse; *we cannot help believing:* and the negative reason why we believe is very often because we cannot help it: we can no more help believing than we can help feeling: evidence is related with credibility just as the causes of sensation are with sensibility; the necessary effect of the relation in one case is to produce unavoidable belief, as it is in the other to produce unavoidable sensation. If the relation is frustrated, then indeed neither effect takes place; and a certain belief is no more producible by certain evidence on a deranged understanding, than the usual sensations are producible by certain excitants in the seat of a modified or impaired sensibility.

§ 22. The modes by which we acquire a belief are three: by an impression on the senses, by recollection, by inference. Belief, or truths, simply of memory, are not produced by a present impression upon the senses, or by analogy; they are merely the recollection of former witnessings, and never produce belief of present existence. But the events or circumstances which are thus furnished by memory, may become the basis of an inference of a present existence. Thus it is a simple act of *memory* to inform me that my father was alive when I was last at his house, it is an *inference* that he is alive *now;* I recollect that he *was* alive, but I cannot recollect that he *is* alive, although I conclude it by a process in which this recollection is concerned. I do not think it necessary to say any more about the evidence of memory, except that in point of force it is, when clear and unequivocal, equal to that which produced the belief which memory renews, and which might have been the result either of an impression on the senses or of an inference.

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§ 23. There is a vulgar axiom which says "seeing is believing;" so also is tasting, hearing, feeling, &c. It is plain that things which are perceived by the senses become objects of belief. Belief, produced by an impression upon the senses, is rarely superseded by a different belief with respect to the same object, the relation of the senses with the external world being more uniform and less complicated than that of the understanding. But in *sensible* matters we are apt to believe more than the senses inform us of; and as it passes under the authority of sensible evidence, in this way the infallibility of the senses is brought under question, and perhaps into disgrace. Thus a man, who, for the first time, should see a shadowy representation of men on horseback, would believe them (his judgment not being otherwise instructed) to be men and horses of flesh and blood; and he would fancy that he believed no more than his senses informed him of. It would scarcely occur to him that he did not *see* the *solidity* of these men and horses, or their warmth, or their organization, or the character in some other respects by which they are identified. But our inexperienced man connects all these latter particulars (whose only relation is with another sense) with that which he sees, or with the effects produced on his faculty of vision, and he would quote the perception of this sense, as the testimony of these particulars. This distinction brings us up to the other mode of acquiring a belief, which we propose to consider: the first has been mentioned above; but lest by this digression it should be forgotten, we will repeat, that the first mode of acquiring a belief of the *present existence* of things, is by the influence which related externals exert upon the senses.

§ 24. The second mode of acquiring a belief of a present existence, is by a process of the mind termed an *inference*, the foundation of which is resemblance. The general nature of this evidence may be thus briefly exemplified: a person who should be shewn a black fluid in a bottle, having the taste, the smell, the appearance, and in the common use of *ink*, would conclude the fluid to be mere ink; and under this belief it would be no great matter of apprehension with him to drink a tea-spoonful or so to oblige a friend, who might assure him that ink was good for his cough; he would, I say, from this resemblance to ink, the composition of which he well knew, *infer* that the fluid was ink, and might be taken in a small quantity with impunity. The ink, however, may contain arsenic; it may be a black arsenical solution, instead of common ink. Again: a man who keeps a splendid establishment, a fine equipage of carriages and servants, and is, as people say, liberal in all his transactions, would be inferred to be rich; because these are the signs of riches, or these demonstrations resemble those of people, who, from a closer acquaintance with their concerns which might amount to an experience, are known to be rich. Yet our man with the equipage may be spending his last shilling, or possibly may not have a shilling to spend.

Inference always proceeds upon analogy, it assumes things which the senses do not witness *in the present instance,* from the similarity of those which they do witness with some which have been perceived before with which the adjunct, the matter of the inference, was found to be connected. In fewer words, we believe things not seen upon an experience of their connection with things seen; or, from analogy which is perceptible in some respects, we *infer* analogy in others. To multiply our examples—

§ 25. Fire is luminous and hot: whenever we see the former property we infer the latter. Now on what does the *truth* (by which I would be understood, when I employ this term, that belief which is not likely to be superseded by another), on what does the truth of this inference depend? If heat is necessary to a luminous body, that is, if a luminous body cannot exist without heat, then we should be right in concluding always their connection; but if a luminous body may exist without heat, then we are not certain of the presence of heat in such luminous body until we have examined it by another sense. As a body may be luminous without being hot, we may be deceived in this *inference.*

§ 26. When we *see* water congealed into the form of ice, we infer that it is cold. In this inference we are not likely to be deceived, because we are aware beforehand that ice cannot exist without the cold which we expect to find. We have ascertained that there is a relation of *cause and effect* between cold and the congelation of the water. Where this relation is known we cannot be deceived, if we *infer* the cause from *seeing* the effect. This then is a *necessary connection:* but there are connections which are not necessary, and it is in our affairs with these that we are so liable to error.

§ 27. What proof, it will be asked, have we of the necessity of a connection? Briefly, universal experience. But if it should be discovered that there is a property in nature, hitherto unobserved, capable of producing such a congelation of water, in a summer's atmosphere, without diminishing its temperature, we should then conclude that the property producing the congelation of the water was commonly *associated* with cold; that cold was not essential to this property. Such a property being discovered, our *inference* of the coldness of the substance, from *seeing* a piece of congealed water, could not be free from the possibility of error.

§ 28. But notwithstanding the discovery of a property capable of congealing water, independent of cold, we should be very much disposed to believe a piece of ice to be cold; and as the independent property had not been noticed in the lapse of previous ages, the sense of feeling would confirm our *inference,* perhaps, every time it was made in the course of most men's lives. And why should we be right so often? Because the association of cold with the property of congelation would be proportionally frequent.

§ 29. Here, then, we distinguish a different kind of force belonging to two descriptions of evidence, viz. certainty, which proceeds from the direct testimony of the senses; and probability, which consists of the frequency of the connection between the thing seen, and the thing unseen, which latter is inferred from witnessing the former.

§ 30. Probability always implies some doubt, as an inference may always be superseded by a perception: but the degree of doubt belonging to probable evidence is proportioned to the comparative frequency of the association inferred, and the absence of such association. Thus a man who should conclude a luminous body, looking like fire, to be hot, would be less likely to be wrong, than one who should conclude such a person to be a Christian, merely because he goes to church; heat being most commonly conjoined with a luminous body, and perhaps not one person in a hundred of those who go to church being a Christian, except just when it suits his humour or his convenience. Experience, or the testimony, in this case, of another sense, would confirm the former inference; and the latter inference would be liable to be superseded, in a proportionate number of instances, by the belief of experience.

§ 31. Upon this simple plan the immense fabric of human reasoning is constructed. We appeal to the senses for unequivocal proof, or a testimony, the impression of which, while the senses preserve common relations, cannot be superseded; and in the absence of such proof we act upon probability, and we rely upon it with a strength proportionate to the following gradations of evidence: 1st, when the connection is universal, we on this account are apt to suppose it necessary; 2nd, when the exceptions bear but a trifling proportion to the frequency of the association; 3rd, when the exceptions are not so frequent as the association; 4th, the judgment is suspended by a recollection of an equal frequency of the associations and of the exceptions; 5th, the inference is negatived, or probability inclines us to the opposite belief, when the exceptions are more frequent than the associations. This gradation appears necessarily true, because we give credit to the inference of a connection, from our past experience of it; and the probability of its occurrence, under apparently similar circumstances, must be in proportion to the times which it does occur, or has occurred. This seems no more than a definition of the common sense of mankind on this subject.

§ 32. In examining the truth of a proposition, our business is to take account of the evidence, which we shall often find to be most complicated; a knot which the understanding ties perhaps involuntarily, and which the understanding by any effort can scarcely again untie. We shall find the facts, authority, or basis of the evidence to be sometimes doubtful; we shall find it ecessary to examine on what the truth of the *evidence depends:*

but we shall not take this trouble, unless the probability of the inference is clearly suggested; which will be judged of according to the above estimate of probabilities.

§ 33. If we think that the evidence of an inference which, as far as we know, is founded on an universal connection, merits the appellation of proof, we must denominate that evidence which is a direct resnlt of an influence on the senses, perceptive, or sensible testimony. The kinds of evidence may then be enumerated according to their force, in the following order:

1st. Perceptive evidence.

2nd. Proof; or that founded on analogy, to which we know of no exception. These two are almost equal in their degree, and generally produce *unequivocal belief:* the

3rd. May therefore be called probable evidence; as when the analogy is rarely excepted against: thus designating this class of inferential evidence by the term which has been employed to denote the whole species.

4th. Indicative evidence; as when the association inferred, is more frequent than the absence of such association.

5th. The evidence of possibility; when the connection or association is known sometimes to occur. These three last, which may be considered as different grades of presumptive evidence, give rise to the diversities of opinion; for as facts are pre-supposed to be in opposition, so their comparison will be attended with a different result, according as one or the other set of facts is recollected.

§ 34. The estimate of probability in all its range is to be made by a comparison of the frequency of association with that of exception. We must also remember that our judgment is best qualified to make a comparison between things with which it is most familiar; things with the collaterals of which, with the circle of whose connections, we are best informed, and have treasured up the greatest number of facts; things, in short, of which we have the most common and extensive experience. Thus we are better qualified to estimate probabilities (or our inferred belief is less likely to be superseded), with regard to events which occur in the world every day, than with regard to things of which we have had but three examples: for though two of these may be in favour of our inference, yet if these examples were more common, we should perhaps find, as we often do, by progressive acquaintance, that such a preponderance was anomalous; that that which in our confined knowledge appeared to be an exception, was in truth the most common order of occurrence.

§ 35. The object of seeking *probable* evidence, is to produce a belief which comes as near as possible to that produced by *perceptive* evidence: and the end of our examination of evidence is, that we should not confuse the degrees of credit which are to be assigned severally to propositions; but that we should think according to the best rules we can devise, for making our *opinions*

such as would be confirmed by our senses, provided they were qualified to take cognizance of the objects, or that the objects were within this sphere. He is best qualified to make a comparison, whose experience is the most extensive; or who makes the best use of it, so as to comprehend in his judgment the greatest number, and the most pertinent facts, which apply to the question.

§ 36. As inference is founded on supposed analogy, the whole business of the examination of evidence, and the right of deduction, revolves upon the truth of the analogy, or of the points of similitude upon which the inference is founded. If the analogy between two things is perfect, the two things are identical, and are to be distinguished from one another only by some associated properties or circumstances. Hence an inference which is true of one must necessarily be true of the other, provided the distinguishing properties or circumstances are not in either case essential to the truth of the inference: if they are, a difference may exist in these respects which may render the analogy imperfect, and the inference untrue.

CHAP. II.—*Causation.*

§ 1. THE most that can be done in order to verify the several particulars of information of which the human understanding can be possessed, is to place them upon such a footing that they are entitled to belief; in doing which, those proofs must be admitted which agree with the relations before spoken of, by which belief is produced. This agreement constitutes the only ground of the validity of arguments, and of our appeal to the judgment of others; and it must be confessed that the various compositions of men's minds afford considerable latitude and variety to the force of the same evidence.

§ 2. The effect of the operation of externals upon our senses and understandings, is to produce an idea of some presence, of something real, to produce the belief of an existence.

§ 3. By an operation of the mind, this idea might be contrasted; and as on the one hand the belief of an existence takes place, so, on the other, a conception of nihility seems to be formed. Now it is granted, and it must be granted, that we have no ideas but those which are originally furnished by some presence, operating on the *senses:* and seeing that the senses are impressed only by positive existences, it will be very naturally inquired how we come by the idea of the absence of existence? I reply, that this idea is founded upon some part of our experience.

§ 4. If a body of large dimensions, of a striking figure, and cognizable to all the senses, but which from an inherent constitution, or from some concealed properties in its constitution, were disposed to pass spontaneously from a solid into a gaseous form (and such things do occur); I say if such a thing were placed before a man, examined by his eyes, his hands, and all of a sudden, without perhaps the interference of any external cause, were to begin to change its form, to expand in its dimensions, to take leave of its solidity, to get thinner and thinner, until it disappeared without a vestige; the witnessing of a phenomenon of this kind would give rise to the idea of nihility, or the cessation of existence; for something was present to the eye, and this something has disappeared: we should say it *was,* and it has *ceased to be.* It *was,* because we were conscious of it through the medium of the senses; this is experience, it has ceased to be, because *we are conscious*

that we are no longer conscious of its existence; *this is also experience.* Our terms of knowledge express very little more than the consciousness which the mind has of its own state: thus it is conscious of being under some sensible impression; the cause of this impression being removed, it is conscious that it is not under the past, but some present, some other impression.

§ 5. The belief of the absence of existence is founded upon a presumption with which the mind is possessed, of the ability of the senses to perceive whatever external objects do exist. If the senses perceive nothing in any place or direction, it is concluded that there is nothing in such place or direction. If the proof of the truth of this conclusion should be inquired for, I reply that such is the *conviction* which the mind has, and which is synonymous with truth, and is as much as can be offered for the truth of a real presence, or for the existence of positive properties.

§ 6. There are exceptions to this intuitive assurance which the mind feels of the ability of the senses to discover whatever is within the sphere of their relation. When we regard what might be called an unoccupied atmosphere, those who know any thing of chymistry would be convinced that they did not regard mere vacuity, that the field of their vision was in fact occupied by oxygen and azote, real existences. This belief is acquired in the way before mentioned, viz. by *inference:* but when an inference does not help us to the conviction of some real presence, and our senses also fail to discover such real presence, then we trust to the presumed sufficiency of the senses, and *believe* that there is no real presence: and we act upon this belief: and we seldom err in consequence of this reliance, because our sensible relations are in general uniform and consistent.

§ 7. An ignorant man need not go far for his example, if I may so say, of nothingness: not knowing the nature, properties, laws, &c. of the atmosphere in which he lived, he would be ready to affirm that *there was nothing* in a bell glass, because it contained nothing cognizable to the senses. Antecedent to that knowledge which constitutes the base of our inference, about the constitution of air, the presence of properties, &c. we also should attain the same conviction of nihility in the same example. But as the case stands, if we remove the air from the bell glass, we then have a specimen of the entire absence of any thing existent, there being no substance contained in it, according either to the testimony of the senses or of the understanding. It is an ancient, and, as it appears, an indisputable truism, that no real existence can arise in this vacuum unless it should be admitted, or unless something, as its elements, should be admitted from without: it is hence concluded,

§ 8. That as nothing (or the vacuum) must for ever remain nothing, so this state of nihility can be changed or interrupted only by some positive cause. Thus far the matter is very clear. But the inference proceeds to affirm, that as a real existence

cannot arise out of nothing, so every thing must be produced by a cause.

§ 9. In examining the history of any particular existence, our first question is with respect to its origin: *it is*—how came it to be? could it make itself? no: for it must *be* before it can act, or have any force or virtue; which is supposing it to be already made. Could it have existed from all eternity without having been created, or without having assumed its present form at any period? no; for these, as appears above, are the terms of a form of existence, viz. that it would not *be*, unless something had made it; that it cannot arise out of nothing, or exist of itself: from whence it follows that it must be indebted for its existence to something else.

§ 10. But on what grounds do we make this conclusion, that a thing cannot exist of itself, or without a cause? Do we *see* this universal law? Have we a sensible testimony in *all instances*, that we thus presume to include *all instances* in our dogma? It must be replied, no: we are but very imperfectly informed of instances; our sensible acquaintance with nature goes but a very little way, we do not pretend that our knowledge is universal; but where the senses fail us we make inferences, which come sometimes very near to the force, or conviction, of sensible witnessings. The present axiom is allowed to be an inference; the proper examination of it is according to the grounds of inference before-mentioned: let us take the result of such an examination.

§ 11. It has been said, that next to the testimony of the senses that proposition comes best recommended which agrees with *all our experience:* it has been said, that a proposition, so enforced, is not to be doubted; that if such a one is doubted, or rather if it is pretended to doubt such a one, we may with more reason reject totally nine-tenths of the conclusions upon which we practise every day, and are seldom deceived: for we are aware of some, though perhaps rare exceptions to the truth of most conclusions; but in our strongest degree of evidence, where from no known exception a necessary connection seems to be exhibited, I say in this evidence we must acquiesce, how forcibly soever we may be inclined otherwise: we cannot chuse; our will may oppose, and we may make a different profession; but our understandings wlll accept as a *truth* a proposition so supported. Let us see whether our first principles of causation rest upon a testimony of this kind.

§ 12. Our views are confined to the departments of nature and of art: of the works of art we have a conviction, acquired by much labour, that they do not make themselves; that they would never exist, as works of art, but by the means which produce them. We have then, in this department, no example of any thing that exists which is not made by something else. In nature, all the several instances will conform to one pattern. As this is more especially our theme, let us pursue closely the thoughts connected with one familiar example.

§ 13. A tree: why does it exist? upon what does its existence *depend?* or, why is it a tree? It is made such by its roots, trunk, and branches; without these it would be no tree: these are the parts of a tree; and if these parts are necessary to the definition of a tree (which may be arbitrary, and is of no consequence), to the identity of a tree, why then the tree could not exist without them. But then these parts—what makes them? The aggregation and arrangement of ligneous fibres. What determines this aggregation and arrangement of fibres? Certainly some cause; for the fibres, if not endowed with this property, or if not affected by some *agent*, would never aggregate or become arranged. We come at last to examine the origin of the fibres: what makes them? Their particles of the same nature make their bulk; and other constituents, which chymistry to some extent can display, make their nature. Then these particles—how are they made? Shall we say by particles still more minute, and by chymical properties? Thus far we may go with the witness of the senses, at last we shall arrive at what are termed elements; and if these elements can exist without the condition of existence before expressed, viz. that they also must be produced by some cause, why then we must give up the universality of our axiom.

§ 14. As far as our experience goes of the *origin* of things (and we have an ample experience in this way, no less than that which comprises all our knowledge of processes or of occurrences), we do not know a single example in which the condition of existence is not this, viz. that the thing would not exist, but for a *process of formation*, or unless it were made by appropriate causes. The elementary substances and particles, it will be said, are exceptions; what then, do we know that these are truly *elements*? mere units, comprising in their existence only a single property? No, it must be replied, we do not know this; but *here* our analyses end. This then is the state of the argument: nine tenths of the objects of which we have any cognizance, are made perceptibly by causes; that is, all the objects, the terms of whose existence we are acquainted with, acknowledge this necessity of a causation, without which they would not exist (and where shall we apply for a *knowledge* of these terms, but where they are manifested to the *senses*?). There are other objects whose origins we know nothing about, and by which, consequently, we are furnished with no experience (and therefore with no grounds for a conclusion); objects, of whose conditions of existence we are not qualified for a sensible testimony; and the inference is, that *these latter require the same process of causation as the former.*

§ 15. The strength of the inference is this: from things seen (or witnessed by a sense) we infer things not seen; we do this as before explained, upon the ground of analogy. In the present instance, is the analogy perfect? It is unexceptionably perfect: for what are the terms of *existence?* is the question; and it will not be denied that the *existence* is mutual, that it obtains throughout, and

is the property of every thing to which our question can be applied, which of course does not respect non-entities. The analogy then is perfect? It must be granted, in all instances? an exception is impossible. And the conclusion which is transferred upon the ground of this perfect analogy, as far as our knowledge goes, is also without an exception? it must be allowed. Then the general proposition, viz. *that nothing can exist without a cause*, is one established upon the first order of inferential proof; which in point of authority has been shewn to be but little below (scarcely a definable inferiority) the direct testimony of the senses.

This is a point upon which we must be very scrupulous: it is not to be admitted without undeniable evidence, and that adduced it cannot be cast aside. It is an important conclusion: a single axiom founded upon it is equal to a volume of principles, in the extent of its application; on this account I think it right on one occasion to be a little prolix.

§ 16. If the hour-hand of a watch now points at the figure twelve, and presently stands opposite to the figure four, would any one doubt but the hour-hand of the watch had *moved?* no. But was the motion of it seen or felt? is it known by a direct testimony of the senses? no: the progression is too slow to be perceptible. It is, notwithstanding, concluded that there has been progression? certainly, there is no doubt of it. How is this firm conviction attained? thus, when a body changes its place, the course of its progression in other examples may be perceived; it may be seen to move (*changing the place is the point of analogy*): when therefore a body has changed its place, though, as in the instance of the hour-hand of the watch, it proceeds too slowly, or, in the case of a musket-shot, it goes with too great velocity, to be seen; yet the body *has changed its place* in either instance; and this is a point of analogy between the latter instances and those of bodies whose progression is perceptible, upon which we found an inference that it would be absurd to doubt. Yet there is no other testimony of its truth, but the universality of the occurrence of motion in bodies which are seen to move when they do change their place. This is a parallel with the basis of our first principle of causation; and many others may be cited, some hundreds or perhaps thousands, all of them affording, according to common sense and received opinion, indubitable inferences.

§ 17. But in addition to the proof of analogy upon which our first principle has been shewn to rest, and which is on other occasions rather less abstract, considered sufficient, there are not wanting other proofs. I would ask, does not our experience in those which are called elements, prove that they are not elements? A supposed elementary particle of matter, for instance: does it not possess weight? does it not exhibit a power of attraction? Independently of these common properties of matter, has it not some nature? has it not some chymical properties, perhaps some vital ones, or properties holding with life an additional relation? all of

which are essential to *identify this* particle of matter. Take away any one of these; make our elementary particle thus much deficient, and the dependence of this particle for its *identity* will also be shewn to be upon its causes; for the same chymical property, supposing it to be that of an alkali, may exist without solidity, or it may exist with a different property of attraction, with altogether an altered relation with other substances. The same may be said of the gaseous elements: who has decomposed oxygen? yet is not oxygen capable of maintaining flame, of producing acidity? It possesses weight, it may assume a tangible or a visible form; and united with another element, with hydrogen, does it not constitute combustion? and in another form, as that of water, does not the same union prevent ignition, or counteract it, having taken place? Do not all these operations exemplify different, numerous, properties of the same thing? and if one of these properties were taken away, would not our *elementary oxygen* be something else? would it not want one property by which it is identified? Who shall tell me then that we have experience of an elementary particle? But I rest not the argument upon this basis. I will even suppose there are elements, five or six hundred elements, to *our perception;* and will trust, as has been done, the proposition to the support which it finds in the right of inference.

§ 18. Now if nothing can *exist* without a cause, it follows that all things are effects. It also follows, that *every thing which exists is made by more than one cause;* a principle which if it can be made clear, disposes very readily of our question about elementary substances.

§ 19. What is a *cause?* The term implies a relation: it is that which is capable of producing something different from itself, which something is called an *effect.* This also is a relative term, it implies that which results from the operation of a cause.

§ 20. What virtue is there in a cause which enables it to produce something different from itself? a question well urged: why truly, none. If a cause could produce an effect which is different from itself, that in which the difference consists, if it be superadded to the cause, must originate from non-entity: which is contrary to our established principle. If it be only a part of a cause, some properties having been abstracted, why then there is no act of production; for that only remains, and is the effect, which was before produced. A single cause is no agent, it is an identity, but capable of no transaction: for a thing cannot supply or confer what it does not possess; all it can supply is itself, or its own identity. How then do effects comprise the cause, and still be something different from the cause?

§ 21. As a single cause can produce nothing different from itself, and as the effect, according to the relative signification of the word, is more than the cause; and as this difference cannot originate out of non-entity; so the difference must on these accounts be supplied by something else. The effect then depends, not upon one, but

upon more than one cause; and as all things are effects, there can be nothing simple and elementary, but all things must be produced by *causes*.

§ 22. The causes which make an effect can supply nothing but themselves, nothing but that which pre-existed; the effect therefore is no new existence, but it is a new form; called *new*, from its having taken place at some known period. Surely, it will be said, an effect appears to be very different from its causes? It must be different from its individual causes, but *is* that which it is made by them all; *the causes must be different individually from their effect, or the whole;* and this, in some respects, is a gigantic principle.

§ 23. The mode by which a cause acts has nothing mystical in it, *it is itself, and no more than itself, and it can do no more than exist.* But it may exist separately, that is, as an effect dependent only upon its own causes. When it performs that which characterizes a cause, viz. when it produces an effect, it is by combining with something else.

§ 24. In this combination there is no new production; both causes (or if they were a thousand it would be the same thing) are changed, so as to exist, still preserving every property which belongs to them, in another form. This other form is the effect which is thus conjointly produced.

§ 25. Causes do not lose their existence in changing their form: although in the effect the causes separately may not be recognized, they cannot lose their existence; the *whole* is a different combination, and of course possesses a double set of properties, which will individually have some share in determining its character. Every thing is liable to be considered as an effect: and all those things are liable to be considered as causes, which, from a relation between themselves and others, might change their form and produce effects.

§ 26. The *relation* just mentioned is an effect, and of course determined by its proper causes.

§ 27. There are effects in which the causes are lost to our senses, as in most or all chymical mutations. These causes are nevertheless discovered in such effects by analysis; and when these causes are withdrawn, the existence which they helped to compose, ceases, or these effects cease. There are other effects where the causes are separately recognized: such are the effects produced by *arrangement of causes*, where the parts are seen individually, but where the effect results, as in other instances, from the combination of the whole.

§ 28. Single *effects* in a body are an arbitrary limitation: they are so if the mind chuses to consider them as such. But the whole body may be regarded as an effect, and then these minor ones come to be regarded as causes. Thus our earth is an effect, so is the meanest particle which helps to compose it.

§ 29. Consistently with the definition before given, and as a test of the relation therein mentioned, *a cause is that without which the effect cannot exist;* it is identified with the effect, and by this cir-

cumstance is distinguished from all associations ; a distinction, however, which it it is sometimes most difficult to make, but which, for the purpose of accurate reasoning, is of all other distinctions the most essential.

§ 30. The *test of a mere connection* is the abstraction of the thing, or property, constituting perhaps a supposed cause, and the permanence or cessation of the effect. If, upon the removal of a connected substance, the effect remains unchanged, the substance in question is an associated or connected one only, and no cause; and the contrary.

§ 31. The *relation* between causes, disposing them to unite and form effects, is sometimes called an affinity; it is, however, an act of causation produced by properties inherent, though seldom or never perceived in the causes. This act has also its effect, which is among the latent combinations of the causes of bodies.

§ 32. Thus we see that causes are identified with effects, that there is no cause which is not contained in the effect, for a cause is that without which the effect cannot exist. There are in the sciences many instances which I could point out, and most likely a great many more with which I am not in the least acquainted, where associations are currently considered as causes. Indeed nobody has been at the pains to define this matter, and it is therefore no wonder that such a mistake should prevail. A person sees at a distance a horse, and he is ready to affirm that the *horse* is the *cause* of this instance of vision; but it is not so ; the cause which produces vision in this case is, according to the common theory, the modification of light; and the same vision (as by the shadowy representation of a horse) may be produced by the same modification of light, where there is no horse. Now this example would be urged as an objection to my principle; but examples should be scrutinized before we give them an application. It will be said (pursuing the objection), the horse is the cause of the idea we have of a horse ; yet we have this idea when the horse is not present: and certainly this cause, viz. the horse, never entered into our minds, and became a cause of the effect by existing in it, in the way described. Let us follow this matter to the extremity.

§ 33. The mistake is this, that a whole series of processes of causation is considered only as *one act*. The stomach and digestive organs, the lungs, the heart, the blood, and the blood-vessels ; the brain, the spinal marrow, and the nerves; the bones, the muscles, the skin, and all other parts, and minutest constituents of the parts of the animal, are the causes of the identity of the horse; by these and by its life, it has certain properties of solidity, colour, figure, &c.: these latter have a relation with light, that is, they conjoin with it to produce an effect; while the internal viscera, all parts beneath the surface, have no relation with light: light has a relation with the eye and acts upon it, while of course the internal viscera, not being concerned in this relation, are not comprised in the effects of it. The cause of vision is the modification of light, producing a

certain perception. Now in this stage remove all these things before mentioned, remove the horse, let also the modification of light be absent, and with it let also the perception vanish; the perception has taken place: this effect has been produced, and another series of causation is commenced. The perception is related with intellectual faculties: the idea of the horse is at this time produced; this idea has its relations with other ideas, and if we want the horse we perhaps look for a halter in order to catch him. All these things *originated* from the horse, we say; true: and the horse, where did he originate from? We may as well begin to date the origin of our notion, of our idea, from thence; because it is plain that unless the horse had first been made, we could have had no conception of him. According then to the ordinary signification of the word CAUSE, the blood which circulates in the horse's ears is the cause of our idea of the horse, yea, and the chymical properties of that blood; and, to go higher still, the manure which produced the grass from which that blood was made; and, to look still further, the animal who excreted that manure, and all his causes for some generations back, were all *causes* of our *idea* of the horse, since we never should have seen the horse if these things had not been.

§ 34. But the remote existences and relations exhibited in the above account do not agree with *our* definition of a *cause;* which is, that without which the effect cannot exist. Now as the effect, viz. the idea, can exist without all these things, and does exist when they are all removed, we cannot say that the effect depends upon *them* as causes, for the effect *is* when they *are not*, or are entirely out of the way of influencing it. If we want a short expression for convenience, we may call these " remote causes," of various degrees of approximation to the effect. But if we desire to know what they really are, we shall find them to be nothing more than a series of changes, which lead to others by processes of true causation, through many intermediate relations. Each of these changes is a distinct act of causation. Each individual change exists independently of all those which went before it (provided such is the relation), and has no ability to *maintain* the existence (which is the business of a cause) of any of those which might succeed to it; but depends only on such causes as agree with our definition.

§ 35. It will be urged, an effect cannot take place without those which are termed " remote causes." This is true: yet these remote causes do not necessarily help to constitute the effect, the effect takes place as the act of its immediate components; the cause which brought them together was the effect also of its immediate components. The difference between such a series of acts of causation, and one single act, arises from the multiplicity of related existences. Examined in this manner, there will be found no example in opposition to our principle, viz. that there is no *cause* which does not enter into, is present in, and combined with, the other causes of the effect. If any such should be supposed, it will be found upon closer scrutiny to be a *connection*, but not a

cause; not indispensable to the existence of the effect: and this must of necessity be true, since a cause can operate only by supplying its own self; and of course where *it is not*, there it can have no influence.

§ 36. Now although this appears to be a true account of those which are called remote causes, yet there are some difficulties involved in it which require to be further explained; no less for the sake of consistency, than for the purpose of exhibiting more fully the true extent of the relation.

§ 37. It is acknowledged that a cause always exists in the effect; or if the effect can exist without it, the supposed cause is none, but merely a connection. But an effect cannot exist without these remote causes; is it not therfore necessary, it may be asked, that any single effect which we contemplate, should participate in the causes, however remote, which led to it? Thus, for example, if a steeple should fall in consequence of being struck by lightning, and a justice of the peace (as a brief specification of an example), passing by at the time, should be killed by a stone which fell upon his head, would not the lightning be the cause of the death of the justice? To pursue the objection, it may be said, stating the case more fully, the lightning precipitated this stone from the steeple, which cause was contained in the stone as long at least as it was actuated by it; still urged by the lightning, the stone fractured the justice's skull; the fractured bone, driven by the force of the lightning contained in the stone, lacerates the brain, in consequence of which its function ceases, and the justice dies. The question is, whether the lightning, by fair constitution, in the true way of causation, converts a living principle into the condition of death?

§ 38. As we find that death may arise from a somewhat similar accident, where there is no lightning in the case; so we must conclude that the effect, namely, the condition of death, may exist, and is identified without lightning, and that therefore lightning does not in this instance mix with the living principle, changing its identity from the living to the dead state. By this coarse illustration (chosen because the processes are obvious) we are furnished with a general distinction explanatory of the laws by which remote agency is governed: the distinction is this, the lightning is a cause only in respect to concurrent agents with which it is so related, as to produce an effect conjointly with them. The extent of the causation of the lightning is dependent upon its relation; which relation, as before explained, is settled by the presence of causes: thus, allowing that the stone contained lightning at the time that it fractured the justice's skull, yet the *relation* between the agents might be, that the bone received properties only common to an impulse of any kind, and had no relation with the lightning by which it might be derived to itself from the stone; or, supposing that the bone participated in the lightning, and thus furnished, entered the brain; yet the effect upon the vital principle would be caused by other parts of the agency, and in no degree by the

lightning, provided the relation of the latter with the series ceased with its passing into the bone.

§ 39. But although this distinction seems a very obvious one, yet there is often much difficulty, nay, it is sometimes impossible to make it: we may define the principle of the distinction, and have no doubts about it; but we cannot assert the truth of our limitation, if it should be required, in all particular instances. Thus, for example, a drop of oil of vitriol, applied to the sciatic nerve pretty near its origin, would produce a convulsion of all the muscles, and perhaps destroy life. Now the properties of the oil of vitriol are related with those of the nerve, these latter with those of the spinal marrow, these last with those of the whole muscular system. Where then, I would ask, does the agency of the properties of the oil of vitriol cease? They produce a change in those of the nerve, which change is communicated to the properties of the spinal marrow, producing a change in them; what then is the relation between the oil of vitriol combined with these changed properties of the nerve, and the properties of the spinal marrow? The mode itself of causation is extremely simple, yet, from the interchange of the process in phenomena, it becomes inscrutably complex. Let us however pursue the question a little further.

§ 40. The properties of the oil of vitriol are so related with those of the nerve, that the latter are made, by combination with the former, an altered identity: this identity has relation with the properties of the spinal marrow. Now this relation must agree with the modes of causation: it may be, that the spinal marrow is influenced by more properties than usual, or by fewer properties than usual: it may be influenced by addition or by privation. Thus, in the natural state, properties of the nerve may be perpetually passing from the nerve to the spinal marrow, as they are from the spinal marrow to the nerve; the combination which is produced by the oil of vitriol and the properties of the nerve, may have no relation with the spinal marrow; the office of this last would then be changed for want of the usual influence: or the relation of the oil of vitriol may be only with some of the properties of the nerve, admitting the usual communication of others to the spinal marrow, this partial supply of usual properties would derange the function of the spinal marrow by privation; or, the relation of the acid may be with all the properties of the nerve, and the combination thus formed, may be related with the spinal marrow; then the relation of the properties of the oil of vitriol, thus communicated to the spinal marrow, may be with all or with some of its properties, thus modifying the result; and the relation of the acid may either stop with all, or some of the properties of the spinal marrow: or the properties of the former, conjointly with those of the latter, may be extended to the muscular system. Thus we see what difficulties oppose the attainment of a precise philosophy, which emulates the knowledge of the causes which

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fix identities, however minutely the analysis might be attempted. It is plain, from this exhibition, that if we cannot be content with the looser or more general information, we are likely to remain dissatisfied for a very long time.

§ 41. This part of the subject naturally leads to another topic: the connection is this, we have talked about a single drop of oil of vitriol producing such diffused and mighty effects, and we see on other occasions how agents, apparently of inconsiderable bulk, operate upon a wide field, and still preserve some title to the appellation of causes. This then naturally brings us to a more detailed view of the *relation of quantities.*

§ 42. It is scarcely necessary to say that by the word " quantity" is to be understood, the repetition of parts possessing the nature of the whole.

§ 43. It has been admitted by those who have written specifically upon matter, that the smallest quantities are infinitely *divisible.* This notion has been said to be come at only by a process of the imagination: but the proposition is further supported by the application of those laws which determine the properties, to the quantities, of things; for, as every property has a certain sum of its nature which is inseparable from its existence, and as every property is constituted by other properties, and these likewise being of certain sums, so it follows that quantity is in all instances, infinitely compounded, the larger, or the more considerable, of the lesser or fewer parts.

§ 44. But this theory seems to carry with it its own refutation: for if the quantities composing the smallest particles are infinite, what shall we say of those which belong to the largest masses? The direct reply is, that they are infinite too. Thus then we have two specimens of infinity, of which one is the greater and the other the less. Now if an infinite divisibility is true in all instances, the difference between our specimens is this, that supposing the division of the parts of the two specimens to proceed together, *ad infinitum,* the parts of each will continue to preserve the same relation as their whole respectively.

§ 45. If we take, for example, so immense a bulk as the half of our globe, from our actual experience of the divisibility of matter, the visible minuteness of its particles, &c. it will almost be allowed without the aid of inference, that the contents of this bulk in minute particles are infinite; especially when we consider that those of a single grain of sand, reduced to powder, are too numerous for our calculation. Yet it is obvious that the particles composing one half of the globe, though they are allowed to be infinite, are not so numerous as those which compose the whole.

§ 46. My business is not with verbal inconsistencies, nor shall I trouble myself to examine whether they exist; it is sufficient for the purposes of correct information to accept the truths which are proved by experience; the only commentary therefore which I shall offer upon the facts respecting this apparent difficulty is as follows:

§ 47. Every quantity may be considered *positively*, as an identity determined by its contents: every quantity may be considered relatively, or in comparison of its contents with those of another. The two quantities, though different, agree in the circumstance of an infinite divisibility, which is the positive property of each; but they differ relatively in the proportion of their parts.

§ 48. Infinite divisibility is a property common to all quantities; but, for purposes of convenience, it is necessary that we should make a supposititious ultimate quantity of the lowest perceptible minuteness: thus in numbers we have an unit, in substances a particle. Now the largest bulks are made up of those particles, and by them the largest bulks possess the property which they themselves possess. If the particle be an ultimate quantity, the divisibility of the bulk, it being reducible into particles, and made up of the repetitions of finite quantities, must be finite; but if the particle be divisible *in infinitum*, then the bulk, being composed of the repetitions of infinite quantities, must itself be infinitely divisible, the whole possessing the quality of the parts, and the parts of the whole; the whole being more than the parts, because the whole contains more of the infinitely divisible particles.

§ 49. It is possible to pursue these thoughts much further, and to start many other difficulties: but to do so would only be to exhibit some subtile reasoning, by which they must at last be reconciled, and the argument would terminate with something like the following conclusion, viz. that every quantity is made finite by synthesis, and is infinite in analysis; that divisibility is a property common to all quantities, and therefore belongs to the least as well as to the largest; that the difference between quantities consists in the various repetitions of infinitely divisible minute quantities, which compose the respective masses.

§ 50. The closest definition of the facts will not permit our considering a *given quantity* as infinite. But when we use this term, we speak of its contents: thus, if the body of a man or a horse were the given quantity, when the analysis had proceeded so far as to have divided him into four or eight parts, we should scarcely say that, pursuing the analysis, upon cutting one of the legs in two we had made another division of the *man*, the quantity composing the man having ceased; nor should we imagine ourselves making a further division of the leg when we were about the fourth section of a toe-nail. The quantity which belongs to an identity is divisible, this being a common property: that quantity reduced to halves, the former identity, *so far as depends upon quantity*, has ceased; then the parts come to be divided and lose their identity, then other parts; a common property of all things being divisibility. Thus, it is not an infinite divisibility of things identified by quantity; but the term infinite is applicable only to their contents. In this account I am scarcely aware of having digressed at all from the enumeration of facts: or if I have, it is only in making a

choice between the two suppositions, of whether the particles, which are too numerous and minute for calculation, shall be supposed to be finite or infinite. Having said thus much of the nature of quantities, it remains to discuss a few points which belong to the subject of *proportion.*

§ 51. Proportion may be considered, first, as it belongs to things existing separately; and, second, as they are conjoined in agency. An example of the former is, as when we compare the size of two mountains, existing perhaps in different quarters of the globe; an example of the latter is, as when two agents combine to produce an effect, in that which has been called the true mode of causation: my business is with the last.

§ 52. A small quantity appears capable of influencing the whole contents of a large one: thus a single drop of sulphuric acid will acidulate slightly a pint of water, containing perhaps 7,680 drops. There are still more striking examples to the same purpose, but it is unnecessary to enumerate them. Now as the amount of infinitely divisible particles is, between these two, very disproportionate, how comes it that the contents of the single drop should be capable of a divisibility corresponding with that of the 7,680 drops?

§ 53. Supposing (as we may for the sake of the argument, though it is not quite correct) that one drop of the water were equal in its contents to the drop of sulphuric acid, then if each were reduced to a million parts, and were reducible no further, the oil of vitriol would be capable of imparting its influence to no more than the *contents* of one drop of the water. Nor is the conclusion different, upon the supposition of an infinite divisibility belonging to each; for if one half of the drop of oil of vitriol were removed, or diffused, the remaining half drop, upon being divided and mixed with the whole drop of the water, would not influence the whole of its contents, because the quantum of divisible particles in the water would be always double those of the sulphuric acid; notwithstanding which, the whole pint of water will be influenced by the drop of the acid, and each drop, each particle of the mixture, will appear to possess the same properties as the whole.

§ 54. But in this case it is necessary to infer that the proportion of the ingredients in their division is equal to their proportion when aggregated; that is, however comminuted and diffused the drop of the acid might be, there will be contents of the quantum of water which are not influenced by the particles of the acid: if the drop of acid be infinitely divisible, so is a drop of the water; if the mixture were confined to the two drops (of the acid and of the water), there would be an agreement or equality of proportion among the particles; but if the acid is diffused among many drops of the water, then its particles can apply only to *combinations of particles* of the water.

§ 55. The law therefore of *proportion* between conjoined agents appears to be simply this, namely, that a given quantum of one agent can affect only the same quantum of another. Hence

it must follow that when a small quantity appears to influence the whole of a large one, there must be some deception in the case which it is proper to examine.

§ 56. The *relation of place* between substances is one, the full efficacy of which I will not attempt to define; rather because it would be long and superfluous than because it would be difficult. However, to sketch the leading points of this relation, it may be observed that when things conspire to produce an effect, the agents, though mutually influential, occupy various degrees of intimacy in their combination. The loosest relation of this description is that of the mechanical kind, where the parts preserve their identity without intermixture of particles, and may respectively be contemplated independently of the whole, as the parts of a house, a table, an animal, &c. Next to these grosser mechanical instances come those of mixture, where the parts are mingled together in minuter proportions, but still not so intimately as to prevent the separate recognition of different components; as, for example, in an imperfect mixture of powders of different colour and sensible properties. The third example is that of combination, where the intermixture is not by recognizable parts, but between the infinitely, or, to speak more cautiously, the invisibly subdivided particles. In this last class of the relation of place, all traces of separate components are lost, and the thing appears altogether of one nature, as in the instances of chymical union.

§ 57. Now this relation of place between agents is settled as before explained by the causes which belong to the agents, they being various and producing the varieties of the relation. But to return to the present topic: the tendency, in the state of combination, of the minutest possible divisions of particles is to separate from the aggregate which they before constituted, and to diffuse themselves to an extent corresponding with their divisibility, and the relation subsisting between their particles, and those of the agent with which they are combined.

§ 58. In this manner, to recur to our former example, our drop of oil of vitriol, if divided into 7,680 minuter portions, would furnish one to each drop in the pint of water: and if this division were again subdivided, one portion to each half drop of the water; in this way, pursuing a division (which in possibility we have before stated the grounds for believing infinite), we may conceive how each thousandth part of a drop of the water may come to possess a portion of the acid proportionately (according to the aggregate differences) less than itself. This then is the solution of the difficulty: by whatever test we examine this acidulated water, whether directly by the sense of taste, or by a cyhmical agent, the acid will be discoverable in the minutest portions; not because there are not particles of the water which are unaffected by the acid, but because there is no test adapted to our faculties or comprehension, the minuteness of which is sufficient to dis-

cover those vastly divided particles of the water, which are not influenced by the still more minutely divided portions of the acid.

§ 59. But a larger is sometimes totally changed, to all appearances, by a lesser quantity: here the proportions of the real agents are in fact the same. Thus a lesser agent may be diffused in the way just described among the particles of a larger, apparently changing the qualities of the whole; and another agent being combined *equal to the lesser* already combined, may have a relation of influence only with the lesser, and by destroying its influence in the general mass, may appear to affect the whole quantity, so much greater than itself.

§ 60. There is yet another, and perhaps a more striking class of examples of an influence communicated by a minute, apparently to the whole of a considerable, quantity: I allude to those of conversion. Thus a single spark of fire will ignite a whole barrel of gunpowder. This cannot be, according to our law of proportions, by a communication of the divided portions of the spark to all the divisible particles of the gunpowder: what then is the mode of this instance of causation?

§ 61. It is simple increase by affinity. To describe the process more minutely: gunpowder contains latent fire (made latent by its combination in *this form*); eliminated fire (as the spark) is related with its own quantum of the latent fire, and unites with it by the force of superior affinity. The single spark is thus *increased* by its union; these *conjoined quantities* have a similar relation with the latent fire within their sphere, and the ignition of the whole is produced by a quick repetition of the same process. These points will be still further scrutinized when we come to speak of the subjects to which they apply. To proceed at present with the other topics of causation:

§ 62. An effect is identified by its causes; but it is so closely connected with other things, that, from meeting with them continually in this close connection with the effect, we are apt to regard them as causes. Every individual cause of an effect, unfortunately, is liable to have these adjuncts and associations, which, from the regularity and frequency of their alliance, are apt to be mistaken for the causes which are necessary to the existence of the effect. There is no way of evading this obstacle to a just discrimination in our pursuit of science, but by defining exclusively the particular effect we mean to consider, and then examining its real dependences. Thus, for example, we may say, atmospherical air maintains life, or is a cause of life: if atmospherical air should be found to consist of three constituents, the real relation with, or real cause of, life may be only one of these; while, previous to an analysis of air, the whole properties, or their combined result, may be assigned as the cause of life; or, after such an analysis has been made, the concurrence of these three properties may be assigned as necessary to life, and they may, from the effect which they produce in their union, be equally considered as causes, until the

relation is analyzed, as well as the atmosphere; until it is ascertained that only one of these constituents of the atmosphere maintains life or is the cause of life, while the others are merely associated. This is merely a supposed example, not true throughout, but chosen because it is familar.

§ 63. In the business of analysis we can specify only this rule, in order to distinguish causes from mere associations (and this rule must frequently be inadequate, owing to our defective means of analysis), namely, to develop *dependences* as far as we are able; to reject as causes all those things which may be separated from the effect without changing its identity; and still to regard those as causes which we cannot discover to be *separable from the identity of the effect.*

§ 64. It is affirmed by some, and the doctrine I believe is almost a fashionable one, that causation is nothing more than the succession of phenomena; that we know nothing more of causation than that there are certain antecedents, which are regularly followed by certain consequences. It is affirmed, that we cannot tell *why* effects should succeed to causes. I do not wish to spend many words upon this doctrine: to consider it then briefly:

§ 65. An acid and an alkali are causes, a neutral salt is their effect: that is, a neutral salt *succeeds* to the combination of an acid and an alkali. But would the neutral salt *exist without* the acid and the alkali? To answer this question we must appeal to our experience; and no one will object to this appeal, because it is the best that can be proposed. Our experience tells us that the neutral salt cannot exist without the acid and the alkali; hence we infer, that the causes, viz. the acid and the alkali, are *necessary* to the existence of the effect, viz. the neutral salt; and we infer that the causes are *necessary* to the effect, simply because the effect cannot exist without them: and this is agreeable to our experience in every example, in which the cause and the effect are witnessed by the senses.

§ 66. Our ideas of the *necessity* of one thing to the existence of another are derived from, or have their strongest illustration in, the *relation of cause and effect.* Thus, we say, blood is *necessary* to the life of a man: we mean it is necessary to the life of a man, because without it the man would die. Thus food also is *necessary* to the life of a man. If any one doubts this *necessity* for food in order to preserve life, let him try to live without it, in which he will certainly succeed if there is no *necessity* for it. Thus, muscles are *necessary* to voluntary motion; thus, too, air is *necessary* to combustion. We have no notion of a case of *necessity* which does not respect the *relation of cause and effect.* If, then, causes are *necessary* to the existence of effects, the next question is, why are they *necessary?* and this is what certain *philosophers,* as they call themselves, or as either in derision, or in the way of civility, they might be called; this is the question which they tell us we cannot answer. Let us try—

§ 67. If a cause is *necessary* to the existence of an effect, the effect cannot exist without it; if the effect depends upon the cause, and cannot exist without it, then there must be some virtue in the cause, by which the effect is produced. So far, so good: we next come to this virtue in a cause.

§ 68. A cause is a *form of existence.* A form of existence has no virtue to be either more or less than itself; the most then that a cause can do, is to exist. Thus, an acid can be neither more nor less than an acid; or if it ceases to be an acid, it is because this form of existence unites with another, as, recurring to our example, with an alkali; and conjointly they produce another form of existence, which other form of existence is the effect; and the *causes are necessary* to the existence of the effect, because the effect ***is the existence of*** the causes, and the existence of the causes is that of the effect. The reason why a cause appears to produce something different from itself, is that in the effect there is a double relation of existences with our faculties of perception; that is, an effect is made by the union of differential forms of existence. These forms of existence in their separate state have a separate relation with our faculties of perception: in their united state, the relation of two forms of existence with our faculties is comprised in one; and hence an effect appears one form of existence, different only from its causes, because the causes when separate have an individual relation with our faculties, and when united they have only one or an aggregate relation with our faculties of perception. The perception of this one undivided relation of causes, comprised in an effect, is frequently superseded in matters of experimental philosophy by *inference.* Thus atmospherical air appears one form of existence; but our inferences teach us, while contemplating a sphere of vision without sensible objects, that the atmosphere which occupies this range consists of oxygen and azote; and if our means of analysis were more perfect, we should ascertain it to consist of fifty thousand things besides. From the same quarter may be drawn many similar examples, which, as they are similar, it is unnecessary to mention.

§ 69. Succession is admitted to prove causation; but we distinguish between succession which does, and which does not imply *dependence.* When one form of existence regularly succeeds to another, and regularly ceases when that other is removed, then we *experience* that the existence of one is dependent upon that of the other; and that the effect will succeed to the causes, and will not exist when these are absent, in all future instances, is an inference founded upon universal past experience. This is the succession which proves the relation of cause and effect; and the proof is established upon these analytical and synthetical tests.

§ 70. But when an antecedent is occasionally only followed by a certain consequence; or, more satisfactorily, when the consequence may exist without the antecedent; then this succession does not prove causation, nor can it be admitted as a *proof.* But

mere succession *indicates causation* by its analogy to the order in which we experience *dependence:* this analogy is to the synthetical proof of dependence; but is often invalidated by the analytical test: that is, the consequence which succeeds in a few instances to a certain precursor, is found, upon further experience, or a closer investigation, to be capable of existing without it. This doctrine will be further enlarged upon in a future instance, where the truth of its application is a matter of some importance.

§ 71. Although in the gross we contemplate an effect as a single thing, yet its properties are infinite, or it includes within itself an infinity of forms of existence. The causes of one part of an effect, by pursuing an analysis, in possibility, justly supposed, are without number: and the relation of the *causæ causarum* of one part, with those of the other, produce individual effects which are also incalculable, and serve to diversify to an astonishing extent the forms of existence. The reason why we do not see all these things is, because only certain properties of things have a relation with our faculties; the others of course have no influence upon them; as an arm is to us a sound arm, though it should be undergoing the preparatory changes of an erysipelatous inflammation, which may shew itself in two hours. Now the arm had digressed from health when we thought it healthy; but the relation of that act of causation was not with our senses. The relation of the vesicles and the redness is with our senses; and accordingly these phenomena are taken account of by them. This is a clumsy example where the choice lies among ten thousand.

§ 72. The chief end of investigation is to understand relations; and these are the more complicated, the more extended the series is which forms the subject of inquiry: but there are few men who have the talent of combining, so as to comprehend in their view a whole system of facts, or who are capable of connecting the parts of an extensive chain; and fewer still who are adequate to the arduous business of just analytical discrimination: and consequently, the relations even of familiar things are still but imperfectly understood.

§ 73. Investigation is of two kinds; analytical and synthetical: and our inquiry observes these modes, whether it is conducted with ocular testimonies, or by inference founded on analogy.

§ 74. The modes by which new forms are produced are two, viz. by addition of properties or parts; and by subtraction of properties or parts. The former gives what the subject of the addition, or the other causes conjoined in the effect, did not before possess; the latter leaves the subject such an identity as is determined by the remaining causes. The proof of this proposition is, that an effect will always remain the same if its present existence is not disturbed; and that no change can happen but by something added, or by something taken away.

§ 75. Identity of effect requires identity of the causes. This is a proposition to which there are many apparent exceptions, which have never been explained; it is my business to reconcile them,

Example of exception: the prick of a pin will produce *pain;* so will that of a needle, so will hot water, or caustic, or an incision with a knife, with a razor, or a scythe; all these things produce *pain:* all these things are causes, yet they are not the same. But have they no relation with sensibility which is common to them all? Why truly they must: and for this reason, viz. that pain can be identified only by its causes. Those causes must be operative which can make pain: if they are not these causes, if they are more or less, they will make something else corresponding with *what they are,* and not pain; or else such a modification of pain, as will agree with the diversity of the real causes. If, therefore, the causes are different, the effect also will be different, or those which we suppose to be *causes* are *none.*

§ 76. To take another example: a *ligature* on a nervous trunk will paralyze the parts to which its branches are distributed. This effect will be produced by thread, by silk, by cotton, by a piece of whipcord or catgut, or horse-hair; by pinching the nerve between the finger and thumb, by applying a red-hot wire to it, by dividing it with a knife. These causes, as they are called, in the gross, are all very different, yet the effect is the same; and why? It is, that they possess in common one relation; or, that the real cause, that which is productive of the effect, is the same in them all: the other appearances, properties, &c. which identify these nominal causes, and distinguish them from each other, are mere associations, or adjuncts, which do not produce the effect, having no relation with the subject of the influence, although connected with a real cause. And what is this common relation? Why, the ligatures, whether of hair, or silk, or catgut, &c. having in common a certain figure, a certain tenacity and strength, which admit their being drawn tight, and thus making a certain degree of *pressure,* are capable, each, by these properties, which are common to all, of compressing the theca of the nerve, and of displacing a circle of the medulla: this is their share in the effect; the phenomena are then left to other causes; and the relation afterwards is, that no nervous influence is communicated beyond a place in the nerve so circumstanced. But what shall we say of the knife, which is different from all the ligatures? The knife produces one effect in common with the ligatures; and as it is a different cause, or as different causes *act,* it produces other effects which the ligatures do not. By it the nerve is divided—what follows? The law with respect to the function of the nerve is, that it requires a *perfect continuity* of the entire structure of the chord. Is not this continuity interrupted in both instances, is not this the *common effect?* or the common relation in which all these agents stand with respect to the nerve, and the phenomena of their application? It must be allowed that it is: and the same does obtain, *must obtain,* if there is any truth in our first principle, in all instances. This confusion of real causes with their connected properties is a great stumbling-block in matters of science: but as the principle has never been reconciled and ex-

plained, it is sometimes respected, as it were, intuitively, and it is at others set aside without ceremony.

§ 77. The cause always exists in the effect. Here we are liable to be misled by successive acts of causation. Thus, to extend in this place a former illustration, a man made a watch: the man is the cause, as may be said, the watch the effect. But surely the man is not included in the watch? Why, no; truly the man has an habitation in England, and the watch may be lying upon the dressing-table of a gentleman at Calcutta. Here we must trace a process of causation; and though an example more palpably opposed to our doctrine will not readily be devised, we shall still find that our principle is untouched by it.

§ 78. The vital organs of the man, his animal powers, his mechanic knowledge, his facility in the art, all concur to produce one effect, which is the exertion of that *ability* which is produced by this complicated causation; this effect, in its turn, becomes a cause, by which the parts of the watch are adapted to each other; the intelligence of the artificer is related with volition, or produces and modifies volition; volition is related with the muscles of the arms and fingers; and modified motion (motion modified according to the volition) is the result; by this motion the parts of the watch are prepared and adapted. So that it is not a *man* with which a watch holds a relation as with a cause, but with a certain moving power, which is the first cause, proceeding from the man, which is exerted upon the works of the watch. If we would know whether this power of motion, or its properties, communicated to the works of the watch, still exist in them, we can scarcely answer this question, without a better understanding of the relations of moving powers in general. The power of motion appears to be expended in the act to which it gives rise. And whether it enters into the substance moved, or whether it is communicated from the subject moved to the surrounding medium, in the course of its progression, is a point which in this place it is superfluous to discuss. The watch being thus produced, is then identified as an effect by its own constituents, and is maintained by relations subsisting between its parts. The powers which concurred to produce it are its remote causes, and these may be withdrawn, or cease, while the watch preserves its identity; its real, true, or efficient causes are those by which its identity is preserved, when its connection with the remote or concurring agents has ceased; and these causes cannot well have a place in England, while the watch is at Calcutta. All this is very obvious, and requires no more to be said about it.

These principles of causation furnish the true basis for inquiry, and are sufficient to lay down here. I shall hereafter see what light they throw upon a particular application; or rather I shall endeavour to shew how we ought to philosophize, in order to be agreeable with these apparent truisms. In the mean time, it may not be uninteresting to see how the general affairs of this world agree with these notions, which I shall do after a looser fashion; intending this rhapsody rather as a interlude than as a regular part of the piece.

CHAP. III.

The Universal Scheme considered in Connection with the foregoing Principles.

§ 1. NATURE and education have produced in man a restless and enterprising spirit. He is delighted with the knowledge he possesses; and acquiring by this a glimmering of some of a more exquisite kind which is further in the back ground, without perhaps sufficiently examining how far he is qualified to attain his desires, he adventures to push boldly on, and had rather substitute fictions for truths than consent to have the scope of his information abridged. In no instance has this spirit of speculative enterprize prompted a bolder research than that in which it has aspired to the discovery of the origin of the world in which we are placed, and of the primitive condition of things. It cannot be disputed but a more perfect information on this matter would be highly gratifying to us: in some respects such an information must also be acknowledged to be of the very highest importance. But we have supposed that the limitation of our faculties excludes us from this rich possession; animated, however, by the hope of throwing upon the subject one additional ray, notwithstanding past failures, I shall just examine how far the question is affected by the preceding notions: some of which appearing to be new either in their conception or arrangement, promise at least to add to our results in the present application.

§ 2. The axiom "*ex nihilo nihil fit*" has been by some cited in support of theism: how far its services in this way extend, or whether it possesses a tendency of a different description, will perhaps hereafter more fully appear. The principle that "nothing can exist without a cause" has been before shewn to rest upon analogy: as a principle, it can certainly be no part of our experience; but though not amounting to an ocular testimony, it is found to be an inference which deserves consideration. The evidence for the principle amounts to this, viz. none of the examples of the origin of an existence, of whose origin we have an experience or sensible testimony, take place spontaneously, or in any way but by an act of causation which has been before described. Without affirming that this evidence is sufficient to establish the principle, or without affirming the truth of any of the principles which may be hereafter

employed, we will just, by way of experiment, examine the scheme which must be acknowledged by those who admit them. But we will not do this, without first bestowing a few thoughts upon the converse of the principle, in order that they might be occasionally compared as we proceed.

§ 3. If nothing can be without a cause, distinct from itself, or, in other words, but by a process of causation, the agency of a first cause is absolutely precluded. But the prevailing system supposes a first cause. If it is asked how this world, those things which we see around us, and we ourselves, came to exist? It will be replied, we were created by the power of an intellectual being, who is self-existent. In consonance with a system of natural evidence, founded upon the preceding data, let us examine how much is implied by this work of creation.

§ 4. Creation is another word for production. This world was produced at a certain period, and until then did not exist, it is said. Did then the intelligent being with whom this creation originated supply the *materials* of the world? For we know that things are made by their causes, however we may be at a loss to conceive from whence these causes sprung. Did this universal artificer supply the materials of this world? If he did, then the materials must have been included in him, must have been identified with him; and the world (as an effect must exist in its elements, or in the sources from which it is supplied, although in them its form is perhaps not conspicuous), must have been coeval with its creator, and consequently could not be produced *de novo*. If the *materials* of this world were not supplied by an intelligent author, then either it exists without them, or else they are furnished from some other source, or in some other way. It does *not* exist without them; for we perceive these materials in all our analyses, and we presume upon them and work with them every day, and almost in every act of our lives.

§ 5. But, it will be said, the mistake lies in the examination of the first question: it will be said, the things of this world do not exist without their materials or their parts; nor were these materials co-existent and identified with their author, but they came into existence at his command. What then, is a command an oak, or a rock, or the sea, or a mountain, or a continent? No; but it will be said, by a command these things were *produced*. In what manner produced? Our *experience* of a command is, that it can produce nothing, or no effect, except in relation with something else. As a sole agent, a command is totally inefficient; but its efficacy is powerful in a circle of relations, which it holds with contemporary existences. The case we are considering supposes it to be a sole agent, for it supposes its efficacy to have been exerted before other things were made. The exclusive efficacy of a command is then to be examined; and what says our experience? A command is something, a power is something, a virtue is something. If they *are* nothing, they can *do* nothing: then they are confessedly

something. Can that something be different from what it is? Why, truly, no; a thing cannot be, and not be, what it is; it seems not allowing too much to say that a thing is what it is. This command, then, this power, this virtue, can they be different from what they are, and still be the things themselves? Can they, without the aid of any thing else, be at the same time a command, a power, a virtue, an elephant, and a rhinoceros? Can they be any thing more than themselves? No, it will be said; but, in the stupidity of repetition, it may be urged again, they can produce something different from themselves. How produce? It must be answered, because there is such a command, there will be also the rhinoceros, or an elephant, or the sea. Then a thing may do more than be itself; and this too without possessing the properties or the materials by which something different from itself is constituted. A thing is a certain identity; it is an existence; it must remain that existence, unless altered by something else, in which case the product will be a mixture of identities; but, left to itself, its only power, its only faculty, is to exist as itself. What is the proof? Every example of existence of which we are informed by our senses. Against so universal a testimony shall we indulge a supposition which is made without any example, without any sanction from our experience? There are two ways, which have been before stated (and which, to obviate some false examples which might be cited, may here be differently expressed), in which new forms arise. One, as when certain parts or properties of an aggregate are separated, and appear as distinct effects; the other, as when two or more aggregates combine to produce a distinct effect: whichever of these is the mode of causation, the effect can in no instance be any thing more than a modification of present existences, which, whether in separating parts and properties, or uniting with parts or properties, must still produce new forms.

§ 6. It is true, it must be replied by one who is neither a fool, nor disingenuous, the argument is not without weight: but we are led to embrace one difficulty for the purpose of obviating another, which is to conceive an origin of things without referring their existence to the agency of that which is called a first cause. Perhaps this supposed difficulty, which thus becomes an excuse for a belief without natural evidence, may be an imaginary one: whether, or how far we are necessarily obliged to accept it, has been before in part shewn, and we shall have occasion for some further examination on these points.

§ 7. For the sake of stating the argument clearly, we will not fear the danger of a little repetition. We will suppose a period before this visible world was created: what existed at that time? An intelligent and powerful principle, a designing author. Then this intellectual being, by a volition, or by a virtue, as it is said, produced this visible world. What do we know of a volition, what is our *experience* of such a thing? for all our thoughts must be brought to this test. It is a mere volition, a mere desire: how

does it become influential? By its relation with something else upon which it acts. How is a result produced? By the conjoined agency of the will, and some other causes, as in man, the material organs, the muscles, &c. with which it is related. Does a mere volition produce any thing which is not a volition; which is an effect of volition? Our experience of the efficacy of volition is, that it can act upon organic substances; and as most of those substances which are said to be under the controul of an universal mind are inorganic, so do they not belong to that class, of the subjection of which to mind and volition *we have an experience.*

§ 8. It appears sufficiently plain that a mere volition can be neither more nor less than what it is, that is, a volition, its own identity, and that it can do nothing unless through the medium, or with the concurrent operation, of something else. And of a virtue: how far is this operative? Why, truly, as far as it supplies itself, as far as it contributes its existence or its identity. Then it is evident that if neither a volition nor a virtue is either an elephant or a rhinoceros, that they can of themselves become neither one nor the other. If they should lead to these resnlts, such results arise from them by the conjunction of causes; in the aggregate producing, or forming, *or being such constitutions,* the parts of which (or the disunited existences of which) are pre-formed. This is our experience, our universal experience, our perceptive information in every case in which an origin falls under the observation of the senses. Have we a right to imagine any thing in opposition to it?

§ 9. It seems then that a creator can produce nothing *de novo;* that he is either identified with things, or concurs only with them to determine the order and combination of effects: and it necessarily follows, if the argument be admitted, that things were coeval with such concurring agent, which latter can have only the force of a cause; that is, can supply only itself or its own existence.

§ 10. There is in the universe a harmony that cannot be contemplated without filling the soul with delight; there is a stupendous scheme of agreement exhibited in all its parts; it is a world that is admirable; and astonishes one no less in the contemplation, than by the wonderful rapture which the contemplation occasionally inspires. This harmony, this perfect agreement, this mutual subordination, cannot be fortuitous, it is said; it must have been so determined by the designing of an intelligent artificer. Whether or not such a world was created, not having existed before, by such an artificer, has been examined above: we are next to consider whether such a one (an intellectual principle) mingles its influence among causes which were coeval with itself.

§ 11. Before we proceed to shew what sort of a world might be produced in consonance with the preceding axioms of causation, we will examine the grounds on which an intelligent designing creator has been inferred from the harmony and adaptation displayed in the parts and structures of the world. Regularity of constitution, adaptation of causes to effects, and effects to final purposes, prove,

it is said, contrivance; and contrivance proves a designer. This, I take it, is a mode of reasoning which has been employed: and it must be confessed that the reasoning is not chargeable with prolixity.

§ 12. How, it is fair to ask, do we come at the inference that nothing can be constituted properly, so as to bear an exact relation with other things, and to work with them for a general effect, but by a previous designing by intellect? or, shorter, thus: what is the proof that nothing regular can be accomplished without design? Why it is so concluded, because we ourselves can produce little better than confusion, unless we think, and frame to ourselves some model of our purposes. Then it is concluded that nothing regular and consistent can take place without design, because we are under the necessity of designing in order to produce that which is consistent and regular. This is the testimony for the inference, which must also be examined.

§ 13. Is this then the whole sum of our experience in the matter of regular and harmonious production? Why, truly, no; if we wish to compose a book, or a sentence, or construct a piece of mechanism (the perfection of which will consist in its relation with something else, which for the sake of distinction we may call a final purpose), we must think and design for it. But in all the spontaneous operations in which we are not concerned, and which are far more numerous than those in which we are concerned, we have no evidence of a designing principle; we see nothing but the operation of causes, we perceive no other dependence: and it is upon our experience of a diversity, that we make a distinction betweeen artificial contrivances, and natural productions; that is, from our experience of the works of design, we trust to the analogy between them to infer the direction of design, where the conduct of it is not witnessed; and relying upon this analogy, we pronounce all works of art to be those of design, in opposition to the works of nature, which being different from those of art, give rise to a *distinction* rather than to an extension of the same class.

§ 14. Sticking close, then, to our experience, the question comes to this issue, viz. as regular production is sometimes a consequence of design, and sometimes the result of causes, in which design does not appear, are we to conclude that regular productions are necessarily dependent upon design, or that they sometimes only proceed from design, or that they invariably ensue, as has been hinted, merely from causes, in the way of causation which has been before described? We find, in considering those questions, that the experience which should guide our decision is rather contradictory, as we have examples of regular production in each way. But if there is any truth in some former predications, design itself should operate in the general way of causes; at any rate we cannot even grant the distinction implied by these questions, without first ascertaining how design itself is formed, and in what way it operates to produce this harmony, upon which the proposition we are discussing is

chiefly rested. I would merely add, what an objector might in this place urge, that we can have no experience of negative existence; but at the same time we are not to supply this deficiency of experience by *inference,* unless the analogy upon which it is founded is at least perfect in *essential points.* This matter has been before discussed in our examination of the grounds and nature of belief.

§ 15. Intellect is no designing principle until it is furnished with ideas, the *capacity* for designing is produced in the usual way of cause and effect: the intellect which we bring into the world with us is a mere pre-disposition: it is constituted a designing principle by the operation of those causes which fill it with ideas, and by familiarity with which it becomes instructed in the relations of causes with effects (the production of these latter being the general purpose of design). The very *capacity for designing,* in every example we have of it, is a mere effect: it is itself the result of a process of causation. And what is its force? Simply that of becoming in its turn a cause, and of having the same relation with the consequences which result from it, as any other prevailing cause might have with the circle of effects in which it is liable to be interested. What then must we conclude from this fact in conjunction with a principle before expressed, but that there are causes which precede and constitute the designing capacity itself, rather than that the designing capacity must precede every act of formation?

§ 16. Will it be said this is true in regard to ourselves, but those causes which we suppose so perfectly free from any designing principle, and which excite our ideas, are themselves governed and directed by an universal principle of intelligence? I ask for the proof, or even for evidence of a much weaker degree; and so fond am I of the notion of such a presence that I will almost force myself to believe it upon weak grounds: of course the proofs I require are those of natural evidence. It must be replied as before stated, that as *we* can do nothing that is worth the doing without designing for it, so nothing worth doing can be done which is not designed. To this it must be answered, that such an assertion is not consistent with our sensible testimonies, which amount to this, that causes (viz. the intellectual radicle and those objects which instruct it) produce in man a designing capacity: that these causes operate and produce this effect without being themselves actuated by design, and that then the designing capacity so produced operates in its turn, and produces effects which are conformable with their causes. Are we to conclude that design actuates every process of causation, because we perceive that it is concerned in some?

§ 17. If this question should be answered in the affirmative it must needs be an arbitrary decision, a mere *ipse dixit;* for it is contrary to the rules of reasoning which we acknowledge and observe in similar cases. We might as reasonably tack up a

syllogism of this kind, viz. it must be allowed that the sea is good, so is this which is usually denominated a house, therefore a house is the sea. This is in fact an assumption similar to that above; it is arguing the perfect identity of two things from an agreement in one single quality, while there is a vast difference in all the other properties which belong to and distinguish them.

§ 18. It appears then that the proposition, that all the phenomena in nature are produced and regulated by an universal *mind*, is founded upon the analogy between these productions of nature and the productions of art, in which latter we *experience* the influence of mind to be concerned. This is the point of analogy: but the inference upon this ground of analogy is liable to the objections before stated, the principal of which may be summed up in the two following:

1st. Mind produces volition: through this medium its conceptions or designings are executed; and we have no experience of the efficacy of volition, except in its alliance with organic substances. Hence there is a dissimilarity between the subjects on which the operation of mind, through volition, is *experienced*, and those on which such operation is *supposed*, and an argument of an analogy cannot well be founded on dissimilitude.

2nd. It is inferred that mind is necessary to produce regular phenomena, because those are disorderly which mind does not produce. At the same time it is affirmed that *all phenomena* are produced by mind: and if this is true, it must follow that no argument can be founded on the contrast between regular and confused productions, or designed and chance productions, seeing that of the latter we can have no possible examples.

§ 19. But if we find that this exposition has no better success than to leave the point at issue still in doubt; if there are those who will assume the title of arbitrators, and substitute affirmation for proof, intending to carry the point by authority where some sort of choice appears to be allowed them; we must then confess that some further satisfaction is required; and, with a view to obtain it, we have only to recur to a principle of causation in order to put the present question upon the same footing as that upon which the principle itself stands.

§ 20. An act of causation, such an one to which may be attributed contrivance, cannot take place, it is said, unless regulated by a designing principle. But design itself, abstractedly, what is necessary to *its existence?* what but the ideas of those things with which it works, or for which it projects? and can these ideas pre-exist their objects? We have in truth no example of it. Where-ever we can contemplate the designing faculty, we perceive that the objects themselves must exist before the corresponding ideas can exist: that is to say, those things must first exist which furnish the analogies, or models of design. This experience obtains in that which we call invention, and is without an exception; have we then a right to conclude against it? If we allow it force, and con-

cede the proposition it indicates, then those things (or their prototypes) which it seems were made by design, are antecedent to design, and so far from being the effects are the causes of design.

§ 21. And now to recur to our principle, which we state to be this, as nothing can exist without a cause; as this principle is founded upon every known instance of origination; so one cause cannot produce it, for one cause must remain as such, and cannot be different from itself: it is therefore necessary that the effect (which is always different from a single cause) should comprise in itself *causes*, different individually from such effect, but the same in the aggregate. Hence it follows that the principle of intelligence, this same designing principle, must be made by causes, or *is their effect;* and as the causes individually must be different from the effect, so there were agents which preceded design, and without the guidance of design formed the designing principle itself: and yet it is said that nothing good, excellent, or regular, can be produced without design; while it must be admitted, agreeably with natural evidence, that design itself must have been produced without it.

§ 22. According then to the preceding principles, which are merely exhibited as a sketch of the indications of nature, the following is the state of the question with respect to the influence of a pervading *intellect*, or universal mind:

1. This visible world cannot have been produced, *de novo*, not having existed in any form before, by mere intellectual influence; since no cause can supply that which it does not possess, or be either more or less than itself, or contribute any other influence than that which is comprised in its own existence.

2. Such universal mind itself must have been produced by its causes; and these latter, determining all effects, determining all operations (since nothing can take place but by them), must govern such universal mind, making it that *which it is*, and making it in its turn concur in the general scheme of causation.

3. That such an intellectual principle might have been formed in the way mentioned; that it may pervade all nature, direct the operation of other causes, mingle with them for final purposes of its own; and that it may arrange and direct every part for the good of the whole (which is as much as we can imagine of the excellence of such a nature); I say, all this may be true, for any thing urged to the contrary in the preceding sketches: but it behoves one who worships truth (or, to speak more philosophically, who is desirous of obtaining and resting upon firm convictions), and who knows how liable human nature is to be deceived by false appearances, to examine this matter rigidly as a question, before he yields to it an implicit belief.

§ 23. It has been asked, first, if there were no such universal *mind*, how came we to have the notion of such a thing? It has been further inquired, secondly, how the notion of an intellectual and moral presence *came to be so prevailing*, that there is perhaps

no people who have not the idea of some powerful and intelligent being who governs the world? For the first question, it is sufficient to remark, that there are such things as fictions, and in the same manner as they arise might originate any notion, and consequently the one we are considering; the notion is formed by the combination of ideas from sensible impressions, and by the assumption of analogies. Thus much is sufficient to shew that the *origin* of a notion is no proof of its truth, for by the same processes we are originating notions, some false and some true, every day. And for the second question, it is only to be observed, that if a fiction is one to which human nature, from similarity of constitution, is prone, it will be very likely to be an universal one, without being the less a fiction. Thus in the more ignorant times, and now among ignorant nations, spiritual agencies were perpetually occurring in nature, and affecting the concerns of men: the influence of the planets over certain affairs has likewise been a prevailing fiction, which however is discredited by men of sense and reflection, because they find no evidence for the opinion; and without this support it is not consistent with their character to fill their understandings with bad conceits, when the value they set upon good ones is shewn by the pains they take to find them. Thus much for the questions: I proceed to shew that the belief of some universal governor is one which men must be prone to slide into by an easy gradation from the common observance of causes.

§ 24. The notion of such an existence might arise out of the almost intuitive assent to a principle which has hitherto appeared to be the basis of a different argument: the principle is this, that nothing can exist without a cause; and now for the application. It is observed, that things do not make themselves: this observation disposes us to look for their causes. As one instance, we will take a human bone (or any other bone), but, for the sake of precision, a human tibia: what produces it, what constitutes it? It will be replied, a bone is made by the union of phosphate of lime, phosphate of magnesia, carbonate of lime, sulphate of lime, gelatine, fat, and cartilage; blood-vessels, &c. exist in bone, and our tibia has a certain arrangement. Now urge the question further, which is very natural, and ask what determines this arrangement? We are not acquainted with the agents, and therefore supposing the necessity of a cause, as observed above, we say, God. Again, the phosphate of lime, if first detected in bones, would be considered a simple substance: if it should, during this opinion, be asked how this phosphate of lime came to be? still retaining the necessity of some cause, it would be replied, it was created by God. But another step of analysis would give rise to a different reply; for when the two materials of which this substance consisted were known, the question, how it came to be, would be answered, "by the union of lime and phosphoric acid." Every example tends to shew that a Divine agency is assigned to begin where analysis, or the knowledge of causes, ends. Thus it happens

that the assigned extent of the influence of the Deity is absolutely abridged as science advances; for as known causes are developed, the unknown cease to be supposed. In this way then the idea of some general antecedent cause comes to be obtained, and it is founded upon the acknowledged necessity of such a cause, which necessity must obtain equally (or the necessity is limited without reason, and in a case in which the universal analogy holds good) with respect eqnally to the existence of the Deity as of other things: this is a point which has been discussed.

§ 25. The notion of a first cause being in this way acquired, men very soon and very naturally extend their imaginations, and they next conclude him to be a *moral agent*. This conception is as easy as the other, and equally fitted to become prevalent, without natural evidence of the stricter sort. Thus, all those things by which we are liable to be affected, are related with us in such a way as to produce either agreeable or disagreeable sensations: the causes of the former we call good, those of the latter, evil. Now who dispenses these? Why, no other than the first cause which made them to exist. Then we come to invoke this cause to bestow upon us what is good, and remove that which is evil, and it is very seldom that we are gratified, except as an ardent desire for the possession of an object induces us to make strenuous efforts to obtain it. Deities are in this way formed by the personification of causes, and, as in the Mythology, a particular God may be assigned to each department of causes.

§ 26. But the main question is this, viz. as it has been shewn that a *designing* principle is not *necessary* to creation and order, is there any evidence which proves the existence of an intellectual principle which mingles with the ordinary causes; and directs them with a moral government, dispensing good and evil consistently *with our notions of right and wrong?* We must examine the evidence for such a moral government.

§ 27. There is a harmony and beauty in the universe, which it is said prove the existence of something intellectual which *designs* for the good of the whole. That there is such an unity and concord in the operations of nature in a general way, is not to be disputed: but how does it follow that this agreement is made by design? I shall not discuss this matter over again, but refer to the preceding pages in which it has been already discussed. Is there any other proof? In reply, it may be inquired, if this pervading mind, as a regulating principle, be not admitted, how else shall we account for the order and regularity which have just been confessed? In order to answer this question, we must proceed in the exhibition of the consequences which ensue from our first principle.

§ 28. It has been shewn that nothing takes place without a cause, and that effects are made what they are by their causes.*

* See Chapter II.

Things, then, are either causes or effects: they are, however, liable to be considered in three ways: first, by themselves, as positive identities; second, in relation to other things, in which light they are regarded as causes; and, third, as effects, in relation to their own causes. All virtue or power is comprised in causes, for nothing can influence which does not become a cause. All effects are produced by many causes; and all things are what their causes make them. Thus much for the present, in the way of recapitulation.

§ 29. If a thing which was before, as we say, *ugly*, should become *beautiful*, what is it that makes it so? Plainly the influence of some cause, or the possession or combination of that in which it was before deficient. But then, it will be asked, what is it that makes this addition, or, rather, who is it that projects a change the result of which is beauty? To this I reply, a cause. Aye, but what cause? One that held such a relation with the agents concerned in the change, as to accomplish the end we have supposed. But is it not necessary that design should interfere in the process? How, I would ask again, does the design act? It can have only the force of a cause; and what is the proof that it is capable of becoming a cause in such an instance, or, in other words, that the agents concerned hold such a relation with design? We will define an example by way of illustration: let it be an imaginary one.

§ 30. It is now February, and this extensive wood looks naked and poor; Nature is asleep in the trees, and she cuts but an indifferent figure. Presently, it is May, and the wood looks smiling, cheerful, luxuriant: the naked branches are covered with leaves, and the appearance is as gay and beautiful as the shade is inviting. Why do the branches shoot forth leaves? Shall we say, because *design* moves the sap? Is it known then that design is capable of putting sap in motion? In truth, we have no experience of it; our experience of the power of design is simply this: that it has a relation of re-agency with the parts and properties of animal bodies; and its influence is never extended beyond the subject in whom it exists, except by a volition which acts on the material *organs*. Now I cannot prove that design is not capable of moving the sap; but it is easy to shew that this is not deduced from our experience, or necessary to be supposed for the purpose of obviating any other difficulty: and it will be seen, at the same time, that nothing is gained by this intervention of design, as it will appear that the same difficulty for which design was imagined will occur again in the questions respecting itself.

§ 31. Ask how the whole is made? By its parts: how the whole earth is made; or, what makes the whole earth? That without which it cannot be the whole earth, viz. by its two halves: and these? By their parts. In this way we may descend to particular bodies, as a stone—by what is its identity determined? By its parts also—but then its figure? Its figure is conformable

with the arrangement of its parts, and depends upon them for its identity. After all, what shall we say of its properties? It is a peculiar sort of stone: it may contain iron, sulphur, &c. in addition to the common properties of matter. Then it is made this peculiar kind of stone by these peculiar constituents. And these, how are they made? Certainly not from nothing: they are not elementary, as already shewn. Or, take a part of an animal, as an arm—what makes its identity? Plainly that without which it would not be identified, viz. bones, muscles, blood-vessels, nerves, &c. What constitutes their identity? The chymical analyses have severally gone some way towards answering this question. But then what brings these together, and arranges these elements, as they are called, in such a way as to make a muscle? The causes which have a relation with these elements capable of producing such an effect—and what are these causes? They are not known; they are not cognizable to the senses. Here, then, the intervention of design is supposed, while our experience furnishes us with no example of a relation which subsists between the designing principle and inanimate particles; for such they are until they are joined together, and obtain a reciprocation of function, as in the form of an animal body. But then, further, this design, how came it (allowing it for the present) to project a muscle? By itself, it must be said. And where did it gain its instruction? The intelligence was produced—by what? By that without which its identity could not exist, by its causes—and what are these? Properties which we infer to be different from itself individually, but in the aggregate forming it; properties which, in our experience of the history of design, are external or distinct from the intellectual pre-disposition, but which unite with it, and form with it, ideas; and furnish it with the models of design. That, then, which we attribute to design, results from causes: of the design we have no evidence; and if it is supposed, this also is governed by causes, an endless chain. It is the business of analytical science to discover these.

§ 32. Such a state of things as that which has been hinted at would be called a mere jumble and contention of the elements of nature; it would be asked, what order, what regularity, what perfection, &c. can ensue from such a tumult? such heterogeneous materials without any directing sense? First, let us examine what that is to which we give names of regularity, order, adaptation, contrivance, perfection, &c.

§ 33. *Why* is a good watch a regular piece of mechanism? Because its parts all concur to indicate time, in correspondence with the motion of the earth; in other words, because they have a relation with an end, or are capable of producing a *certain effect*, which is to indicate time. Now supposing that the parts of the watch were different, or differently arranged, so as to make the hands move round the dial-plate sometimes three times in an hour, and sometimes only half way round it in three hours; what should

we say of the order of its parts? It would be said of them, they want order altogether. If it is inquired why they want order? it must be answered, their relation is not to indicate time correctly. But in this reply we make some addition to our first proof of order, viz. that which says it is the relation of parts with a certain end, for the parts, &c. of our lying watch *have* a relation with a *certain end*, viz. with that which they accomplish. It is not, then, the arrangement of parts, agreeably to any purpose which constitutes order; but agreeably to the purpose we *desire*, regard, or like best.

§ 34. We say then *that* is orderly and regular which suits our convenience, or which pleases us. And is this any deviation from the other processes of causation which we do not call orderly and regular? Let us see. Certain things have such a relation with us as to please or suit us; other things, acknowledging other relations, perhaps displease or do not suit us: what is there in either instance but a common act of causation? The causes which *we dislike*, perfect something else, or agree with another end; those which we like, are equally disagreeable in another relation; there is in both instances an order or concurrence, the same in character, but the instances (or the causes) are themselves different; and very naturally, and very orderly, belong to different purposes.

§ 35. But *order*, it may be said, is exhibited wherever there are any traces of *method*, whatever may be the end produced. And what is method but an arrangement for specific effects? *And what effects ever do result from an arrangement, whether of the sands upon the sea-shore, or of the fibres of a leaf, which is not equally specific in regard to them?*

§ 36. It appears, then, if by the word "order" is meant the subserviency of parts to an end, that "order" must obtain in every process of causation; *since it is the peculiar or inevitable business of causes to produce an end.* If by the word "order" is meant a similitude to the works of art, this similitude exists but partially; and the reason why it exists at all is that certain specimens only of the works of nature are so related with our faculties as to induce imitation, and to furnish the models: we shall not, however, be able to discover a difference of character between those works of nature which have certain points of resemblance with our imitations, and the universal results of causation. The difference is in the end, not in the character; for the most that can be said of the parts in either instance is that they concur, or are subservient to the end. It is plain that the distinction implied by the words order and confusion is arbitrary. If the materials which make a man should be so arranged as to make a pig, we should say that the arrangement was disorderly for making a man, but quite orderly for making a pig.

§ 37. The same is to be observed of *perfection*, which is also a relative term. Every identity must be perfect, *because it is itself.* In this sense there is a positive perfection: if the thing were changed, it would be imperfect *compared* with that which it was

before, but perfect in another identity. Thus, a man is perfect as such, while he retains the identity of a man; and the worms into which he degenerates are perfect worms, but imperfect men. The word *perfection* is most commonly used in the relative or comparative sense.

§ 38. Now supposing it possible that an entire change were to take place in the world; suppose that the causes of which it is composed were, in every instance, to make a different combination or effect; suppose that roots, now nutritious, imbibed from the earth poisons; suppose that trees contained, and were capable of evolving the bodies of elephants; suppose that men had more than five senses, and as many heads as fingers, and these latter doubled; what would be the consequence? Why, *perfection.* If all the parts comprised in such a state did not *agree*, if there was not ***absolute harmony of relations;*** what then? ***Why then such a state of things could not exist;*** but *another* in which there was this *harmony of relations:* for if there is not *agreement* and *compatibility* in one state of things, things will be compelled to adopt another, in which there is agreement and compatibility: this is a truism. There must be agreement then with any state of identities; when there is disagreement with present, there is agreement with a new state of identities, and that new state is adopted; otherwise, if the past subsists, there was agreement in the past: this also is obvious.

§ 39. What shall we say more than this for the present state of things? We can do no more than insist upon this harmony, which is a necessary one under all circumstances. But it will be asked whether the present condition of the world is not the *best?* This is a different question, which is answered thus: if by " best" is meant most agreeable to the present state of man, we *perhaps* should not err in asserting the affirmative; but if by " best" is meant any positive excellence, which is independent of man, why then it remains to be known what this excellence is. It cannot be affirmed that in another state of things, man, preserving in an altered identity some characteristic traces of his present nature, may not be better off, and the state of things be better for him, than at present; for his faculties may be improved, if his means of knowledge, or his senses, were multiplied: his body would be improved if his strength were greater; if its causes were permanent, not apt to run into disease, and indissoluble; and his happiness would be enhanced if there were such an agreement between his sensibilities and his circumstances as to ensure great and unremitting felicity. I would urge, further, that man does not know how far he ought to consider the present state of things as the " best," according to the meaning before conjectured to belong to this word: I say he does not know this; for though he is acquainted with a condition of existence which is neither wholly happy nor wholly miserable, yet he is totally ignorant of his future fate, which is of the greatest impor-

tance. But suppose that man had never been? why then his materials would have been otherwise combined, and they would then have held *true relations*, though different from those which they now acknowledge. In saying thus much with respect to man, I am anticipating another part of the subject. Our business is not to conjecture whether things may be changed for the advantage of man; but to gain a rational understanding of how things exist as they are, and to what forces are to be assigned the determination of existences.

§ 40. If it should be said, although in another state of things there must be the order or relation between causes and effects, yet things may nevertheless be very disorderly; the active principles may be for ever changing the form of the passive materials, there would be no stability, no permanency: I reply, if stability and permanency are necessary to *order*, then it now exists but partially; for combinations are now perpetually shifting their forms, changing their alliances; and man himself, all confident and important as he appears, is but the creature of a day.

§ 41. Granting, then, that agreement exists now, and must exist, under every form, it remains that we should examine to what this agreement is to be attributed, either in the acknowledged, or in the apparently objectionable instances.

§ 42. The senses can instruct us a considerable way in the solution of this question; common inferences will instruct us still further; and the principles before mentioned, will leave us but little to expect from further investigation. Thus, a clock would be no clock without the wood, brass, &c. of which it is composed. What makes the wood and the brass? Causes of which chymistry can perhaps shew us one division. And what makes these? Other causes which analysis has not reached. But these parts require arrangement? True, this is necessary to the identity of a clock. And how is this arrangement accomplished? In the usual way of causation; thus, from a relation of agency between the hands of man (as causes) and the brass, and wood, &c. And how is such a precise arrangement formed? By a relation between the muscles and volition (as causes). And how is such a particular series of volition determined upon? By the designing faculty. And what produced this? An intellectual predisposition instructed, or *made the designing faculty which it is* (from whence results this particular act of design), by the *causes* or things which surround it, and with which it is related. But what made this intellectual predisposition? Causes not analysed. (*Ex nihilo nihil, &c.*)

§ 43. Now if it be inquired what determines the *universe* to be orderly or disorderly? what makes it such as it is, or what would make it different? I reply, causes. I repeat the manner of causation: it is this: things are certain forms of existence; they remain separate, and are contemplated as effects; they unite with others, and become causes; the materials of their original state are not lost when

causes produce effects; but they are disguised to us, because two things have not the same relation with our perceptive faculties, as one thing; and after a process of causation, we contemplate a *tertium quid*, which is an aggregate of the causes. This is clearly, and, what is more, truly illustrated in numerical changes: two and two make four. Why? Because two and two *are* four, or four *is the existence* of two and two; if one is added we make five, for the same reason; if one is taken away the identity is what the remaining causes make it, or is the existence of the remaining causes, or three, &c. Things are what their causes make them, for where there is not production, and where there is no cause, there is unchangeable nihility. The foundation of this principle has been before fully discussed.

§ 44. The *causes* of the universe determine its harmony, or its seeming discord. If it be asked why this fine arrangement is apparent? it must be answered, because such is the force of the existences which make it what it is; and if they were otherwise it also would be different. Thus then we may venture to exhibit the views which would agree with the principles unembarrassed by our duller reasonings; and, in some such form of soliloquy as the following, we may suppose an enthusiast in these views to express himself.

§ 45. Great Nature, by whatever name expressed, it is to thee I address myself! thee I contemplate! thou art my theme: but where begin to think, where begin to speak of thee! I view, at night, a large expanse of hill and dale, shaded with trees, clad in luxuriant verdure; or naked, sighing at the rude attacks of wintry blasts. Imagination paints the extent beyond, where earth is mottled by other shapes and clothing; with other animals to enjoy her fruits. From this terrestrial scene, the view ascends to those revolving orbs, this lofty dome, adorned with stars and planets. These things I contemplate, and wonder, Nature, at the vastness of thy space and works; thy silence breathes into my soul; all is immensity, engendering wonder. Yet this first impression once abated, a speck of thy production, with faculties, the offspring of thy bounty, presumes to scan thy methods, and pry impertinently into ways which thou hast studied to conceal. But forgive the trespass, it is love of thee that prompts this curious zeal, and guides my thoughts astray; it is thy work, that they should adore thee; take it, therefore, not amiss, that falling from the amazement which is first inspired by thee, I seek to know at least thy scheme, though ignorant of thy means, thy instruments, and subtler agencies.

§ 46. Thy movements give birth to time, yet thy existence acknowledges no period; thou hast made time, and wilt not be obedient to thy creature: we boast some records of thy existence, and presume to fix a date to thy beginning; but if *then* thou didst *commence*, from whence derived? or how start forth from nothing? Thy own nature, thy inherent and proper forces, had no share in

thy origination, for that would be to date thy actions previous to thy birth. How then didst thou begin? Methinks, the spirit of the hills, at the question, shakes from him his beloved repose; himself, a part, speaks with a commissioned voice the language of the whole; yet it is a voice sweet and soft, it floats like a zephyr, and is heard only in the stillness of the world; it is a whisper to the soul, which swells when it comprehends the great idea, and echoes thus the truth, in accents of its own: "Search not when that began which always has been; ages and ages have revolved, myriads of changes have been wrought, forms have been made, endured, and vanished; destruction has succeeded quickly to creation: yet Nature was, before all this; her processes were repeated in periods infinite, which thou, with a capacity for finite purposes, understandest not, but must still think true."

§ 47. Is then great Nature indebted to no other power but her own? Say what this other power is, and try if here our thoughts of *infinite duration* succeed more happily; *something* had no beginning then; the voice is surely no chimera: hark! it speaks again:

§ 48. "What in this world, which so excites thy admiration, canst thou perceive but an assemblage of forms? Thou wouldst know when and how they came to be. Oh! dull perceiver! little dost thou deserve to rise to universal truths, if thou so readily canst overlook what in thine own experience is without exception. Observe of things which *are*, but *were not:* thyself observe. The sun has not yet thirty annual courses run, since the creatures which are like thee knew thee not: ask how thou camest to be, what has produced the thing thou art? Thy history is clear; thy formation has, throughout, been passive; that which thou hast, by which thou dost exist, is given thee; nought hast thou but what is conferred; conferred by whom, or what? A form thou hadst prepared for change, from others like thyself derived, but most imperfect. And what made this? thy curiosity would ask. It is plain, an assemblage of existences, of occult forms or properties, whose being is inferred, because *existence* is their effect, but which to develop will yet for centuries to come make full employment for the restless spirits of thy kind. But this imperfect form derived, the earth feeds with constituents, animals, and plants: these transfused supply thy growth with its materials, and thy accessions are as they are furnished."

§ 49. Yes, this is the manner of it: existences all related; and their relations fixed, not by themselves, but by the force of the existences which are included within themselves; *existence still maintains existence, and nought begins where no existence is.*

§ 50. What sum of admiration is sufficient for this grand world, enclosing in itself an endless series of forms and combinations! Existence still springing from itself, and by itself perpetuated; whose beginning no time has witnessed, whose end no period will define; existing without our knowledge how; describing various

shapes, pursuing various changes, none occurring but existence still compels; all enduring in their present, or in other forms, *because existence has no power to be nothing.*

§ 51. The stars are yet upheld; great bulks we must acknowledge them, apparently above us; and they fall not, though propped only by light etherial columns. Who shall say why they keep their spheres? who shall say what they are; whether constant, or at periods produced by agents which we do not know, in worlds teeming with things and processes of which we here find no examples? They govern not themselves, but are obedient to their own constituents; there, too, existences are causes, and all we contemplate in them is yet compelled, *effected* by existence.

§ 52. The sun is present, and imparts to us both light and heat; it is formed by its own causes; these, or its grosser forms, by others, an endless chain. In turn it sends to us some causes, which it well can spare: to us it sheds existence, which mingles with our substances and creates new forms.

§ 53. The sea possesses by a natural right, the deep dominions over which it rolls. This vast property it claims by force of causes which with it abide; it seeks the lowest parts, and terrifies its confines all around by bold incursions on the soil which man calls his; it foams and dashes against great rocks, a bulwark formed to check its aggrandizing spirit, and make its waters still recoil upon itself. Fruitless ambition! thy powers have but their scope; and further, earth is too mighty for thee, as it, in thy dominions, and all its fine productions, are but a weakness, serving for thy pastime.

§ 54. Myriads of waves roar and froth, or, gliding smoothly, glitter in the sun upon thy melting bosom. Not one of these that moves, but moves as 'tis impelled; it, passive, an effect; in turn impelling, then a cause; all more minutely propertied; each particle which we suppose, but cannot see, of the same quality with the whole: fluid and salt; one while upbearing, then yielding; at one time pleasant and salutary for those of a different element, at another, threatening, overwhelming, and destructive; now, transporting rich freights in safety to the shores, dispensing wealth and luxury, then swallowing without remorse, this merchandize (the sovereign curse of nations), and bringing ruin, as indeed is just, on those who rest their hopes and fortunes on such trash. Thou, too great sea! endless in thy relations.

§ 55. Thy movements observe a method even in their roughness: one while thy waves overstep their present limits, the pebbles on the strand are seen no more, thy presence hides them, and they chafe and fret, obscurely warring with each other, where no witness is to tell the fate and history which must belong to each. They, by their causes, are, where we observe them, still passive; they are removed, or broken, or rest, or remain a whole; or are collected, some fused, some ground on roads and then manure the fields; or else are washed along, now backwards, then onwards again,

traversing the uneven bottom of the deep from shore to shore. Again the waves retire, the sand is wet, the sun compels from it a contribution, and it is dry; these changes regular, flux and reflux, marking periods, and obedient to some other power. What other power? The moon, they say; but this is perhaps a fable, coincidence is not causation; still by *some* power governed in this regular work; again connecting the great sea with unknown things, an endless series of relations.

§ 56. But our parent earth supplies to us more varied interests: our native soil is quite familiar, and we are told of worlds abroad, desolate or rich, where animation fails for want of means; or where nature, prodigal, spontaneous, yields more goods than can be enjoyed.

§ 57. Africa, *scorched* by the sun which should but warm, presents varieties of her own. Here woods, water, fruits, men, beasts; there, oceans of sand, which mingle with the wind, and bear rapidly distress and ruin: but here the inanimate causes sport mostly for their own amusement; while the wind howls in the desert, and the sand flies in columns, sometimes upwards, then in vast clouds onwards borne, the tiger crouches, unconscious, in watch for his prey, and the savage is asleep in his hut; each, each, and all, *governed by existence, forcing existence, by causes.*

§ 58. Asia, wide separated, is yet joined to Europe by intermediate causes and relations. Man, adventurous for he knows not what, brings from this soil materials of luxury and corruption. Here the earth teems with new varieties: here the elephant, nourished and developed by the productions of the land, is domesticated by man, and rendered by this connection more mischievous than nature would have made him; he, by this new association learns to fight battles not his own, and is taught a treachery to his species, which should belong alone to man.

§ 59. America too has her phenomena. In all these quarters of the globe myriads of inanimate processes, of the peculiar kind, take place, all governed by their proper causes. The animate creation is also wonderfully variegated, and nature seems to have set apart districts and countries for the reign of animals, all things concurring to their wants, as in the more civilized parts she, suffering the dominion of man, appears to have made every thing subservient to his purposes.

§ 60. Europe presents a more familiar scene. Here nature and man work more conspicuously together: the former prepares materials, the latter works them into forms; their operations sometimes mixed, sometimes exclusive. The trees in the forest bend as the wind impels, or their leaves are made wet by the storm; they shoot forth their branches and grow rich in foliage, and they stand erect in their majesty; their present causes yield to others, the green twig withers, or the strong arm becomes sapless, their leaves are no longer sustained, and they return to the earth; or their

whole bulk, their uprightness, and their majesty, are all levelled by the woodman. Then begins with them another series of causation.

§ 61. But of all productions of the earth the most interesting to man are those which come nearest to himself, the various tribes of animals: these, all curiously endowed, by other causes first disposed, the earth maintains them; they for a while enjoy their faculties; effects produced: causes, producing, they then exchange their properties, and return to earth, assuming new forms, and become the actors in another scene.

§ 62. What in a general way shall we observe of man? In truth he is a theme too complicate for general remark: he, however, pursues in every point of view, in every single act, and in their combinations, the universal order; related with his own causes; these infinite; he, an effect. His causes and associated attributes, with surrounding existences allied, affected by, or changing them: still an effect; or in turn a cause. How he is built up, we need not say; the drama of his life need not be told; what he returns to is also plain. Thus then in more sober form the order of the world proceeds.

§ 63. The universe is identified by all its parts; these last by their constituents, *in infinitum.* The produced contains the producing.

§ 64. Causes have their sphere of influence; that is, as they operate only by supplying themselves, they are causes only where they exist; further the subject of their past operation is taken up by others, and a continuous history of its changes may be preserved to all appearances, when no trace remains of the identity which was formed by preceding causation. Thus

§ 65. The sun encourages the growth of the stick which becomes the bludgeon of a highwayman, by which a man is killed: his family is for a while supported by the parish; a son enlists as a soldier, and a shot from his piece occasions the death of a general officer, whose widow and nation lament him. None of which would have happened, had not the sun, all pervading, encouraged by his influence the growth of the stick. Yet the sun-beams which warmed the tree, are not the *cause* that one became a soldier, who might otherwise have been a tailor, or of the death of the officer, whose fate his country laments. These are distinct, though connected acts of causation, and every cause concerned is to be considered as such only where itself exists; to that which can exist without it, it is no cause. (See Chap. II. &c.)

§ 66. The appellation of "remote cause" is given to express the relation between the sun and the ultimate effect, viz. the death of the officer, in the example just given. This appellation might as well be retained, since its implication cannot be expressed without more words; it must however be understood that there is no such thing as a remote *cause,* of the description hinted at in our example, simply for the reason that the expression implies a cause, that is

not a cause. The man who plants an apple-tree is not the cause of an apple; he is concerned as a cause only in the planting of it, which was an act accomplished by his powers; but the growth of the apple is dependent upon the causes which constitute it, these upon others; some are retained in them and are essential to the identity of the apple, and still preserve the character of causes; others, of remote connection, have passed into different forms, and as an apple is identified without them, so they, in respect to it, cease to be causes. We will however admit the term for the sake of a short expression, and thus conclude our exhibition of the order of the world.

§ 67. Effects are portions of the whole, which by us are considered separately, because such is the relation between them and our faculties. These effects are the most conspicuous to us when they appear in the shape of gross bodies. By analysis, combination, &c. gross bodies may be rendered some fluid and others gaseous; and then we only recognize certain properties which belonged to them. Previous to this decomposition they appeared homogeneous, and holding a perceptive relation perhaps with all the senses, at least with those of vision and touch: subsequent to it, they appear to be composed of properties which have a perceptive relation with only some of the senses, or perhaps with only one particular sense, and then losing the characteristic of an aggregate of the properties of matter, the body ceases to be material. These component properties are not self-existent, if there is any truth in the article on causation, but are constituted by others *in infinitum.* But analysis being imperfect, the force of the causes which make these properties has remained unchanged, and their respective identities are still preserved, (or suffering, spontaneously, decomposition, are no longer objects either of sense or inference,) and are therefore considered as elements. These causes were not thrown in the way of combination by themselves, but by that which has been called a remote cause, but which might be no cause at all. For every thing which takes place there is an adequate process of causation, simple and undeviating, and the combinations which do take place, are those of which there are the causes which produce them.

These are the outlines of a mode of philosophising, the detail of which will be best developed by extending the application; for which purpose I select the general history and condition of man, as a subject which of all others stands most in need of elucidation, and at the same time is more agreeable than any other with my habits and pursuits, hoping that if these principles do not conduct us to a satisfactory understanding of this complex subject, they will at least serve as a clue to the proper manner in which its investigation is to be attempted.

An apology or justification of another sort, may to some appear to be required for the discussions which this section comprises.

If it should be charged against these doctrines that they are subversive of religion; I reply that such a charge is totally unfounded. The Christian religion is proposed upon authority: the *ground of its adoption is faith;* and this is a part of the religion itself. If the truths of Christianity were such as were capable of being made manifest by *natural proofs,* there would have existed no necessity for a revelation in order that they might be embraced. Christianity sets nature aside, and entirely out of the question: it is proposed by its author that it should be accepted in the way of confidence, or trust upon his authority; and whether natural testimony concur with or oppose the system, is a point which does not at all affect the grounds or terms upon which it is recommended. The true and only source of proof, by which the existence and moral government of the Deity can be consistently established, is revelation: and the belief must be taken up upon this ground, in whatever point of view nature or physical testimony might be regarded. It is allowed by the most orthodox, that the facts recorded in the New Testament, as the miracles, &c. of Christ, *are out of the common order of nature,* and that they exhibit a power of which no man has ever had the faintest glimmering of experience. Yet these histories are believed, in the way that is proposed, viz. that they should be accepted as matters of faith. If natural evidence tended to produce the same belief as that enjoined by revelation, nature would be referred to as a testimony of the truth of revelation: the system of revelation would only be an exposition of the system of nature. But revelation is proposed only upon one ground, viz. faith: and it is even *contrary to our religion* to adopt it upon any other basis.

I cannot help thinking that some who have cited natural evidence in proof of the truth of revelation, have gone further than they were sanctioned by the creed they professed. They have endeavoured to establish Christianity, or some leading points of this scheme, upon a different foundation from that upon which it was proposed: and as their attempts, if they were even more complete and successful in their issue, can make nothing in favour of a scheme, which, to be adopted as the letter requires, must be adopted upon another basis; so the total failure of these attempts can detract nothing from the credibility of the revealed accounts. In short, it matters not how nature is represented, in what light she is made to appear, or upon what party her services are engaged: her voice in the affair is protested against, and the inadequacy of her testimony declared, by the proposition of a system upon a *higher authority,*—upon an authority superior to that of nature.

The ground upon which Christianity is proposed, viz. faith, is one, which, though founded upon our experience, as every kind of evidence must be, is capable of superseding other evidence, which is also founded upon our experience: this happens every

day; and therefore there is no reason why Christianity should not be embraced, although its principles should not be agreeable with our experience in other respects. It happens perpetually that we believe accounts of strange, and, as we say, *unnatural* occurrences, upon our faith in the veracity of the narrator. Our only commentary on these cases is, "unless I had every reason to believe that what you say is true, I should scarcely credit assertions so contrary to ordinary experience;" but that the things asserted are contrary to ordinary experience cannot be disguised, though they are still capable of being accepted, and firmly believed, upon the reliance we place on the competency and veracity of the witness. So the case stands in some respects between natural and revealed evidences concerning religion: we cannot disguise that one part of our experience inclines us to a certain system of inferences; but if these inferences are controverted upon what we esteem better grounds, they must be rejected, and others accepted in their stead. Where two systems are at issue, that must be preferred which is recommended by the best evidence; and the general adoption of that of Christianity in this case, appears to shew that, according to the common sense of mankind, the scheme of Christianity, resting upon authority, and faith in that authority, is better deserving of credit than that consisting of inferences from the observation of nature, who is, it must be confessed, in such intricate matters oftentimes a deceitful guide. In the mean time physical truth or science continues to be investigated; and nations unite to complete the system of physical science, professing only a design to augment the sum of their intellectual attainments, and admitting still that there is an evidence above that which rests upon a physical basis.

But although in the preceding sketches physical and revealed evidences appear not entirely to agree, yet in fact their results are not altogether so incompatible as may at first sight appear. If instead of investigating physical topics as such, and merely taking account of the evidence of nature that is derived from the relations of cause and effect; if, instead of doing this, I had been desirous of exhibiting a system of natural *Theism*, the preceding views furnish the materials, and the whole account, so far as it goes, might have been made to agree with the implication of the letter of revelation, merely by a nominal change. It would have precluded fancy and gratuitous assumption; but it would have made those who thought proper to accept it Theists upon physical proof. I profess myself (as the nature of my profession may by some be not understood) with all sincerity to be a firm believer in the existence of a Deity; and I ascribe to this Deity, even on physical testimony, perhaps all that revelation strictly requires, assuming, as is allowed on all hands, that some licence is admissible in the interpretation of the letter; that some expressions are adapted to the sense, and to human views, and are not to be

understood literally. But although with this *sanctioned* limitation I profess myself a Theist, my notions differ perhaps from those of others in the nature of the real agency of a Deity, and, as I can perceive, in this respect only; and if the question belonging to this real agency were proposed to ten of our most orthodox religionists, I am confident that they would, by giving a different answer, or perhaps no answer at all, at least by not agreeing in their accounts, shew that my difference of opinion was upon points on which they themselves are not agreed. However, all this is foreign to my purpose, which is to investigate the laws of physiology, to which I am pledged by my calling legally and morally. For this purpose it is necessary that every sort of light which can assist in their elucidation and development should be brought into the service. If I am reproached with having thrown a *false light* upon the subject, let this be proved, and I am ready to acknowledge it; my consolation then will be that even the promulgation of error is one step towards the advancement of science, more especially when it serves to *lead* the pursuit.

BOOK SECOND.—ON THE ORGANIC ORIGIN OF MAN.

SECTION I.

THE constitution of man has been divided into the organic, animal, and intellectual departments. As these are variously blended in the subject, giving rise to complex relations, so this precise definition of three parts, where the whole seems to form but one, must be confessed to be in some degree arbitrary. But as the division is indispensably convenient, though in some respects imperfect; and as it is, to a great extent, conformable with the division of which nature has on other occasions furnished us the examples; we appear warranted in adopting it, provided the detail does not assume, in consequence of the classification, a distinctness which is not agreeable with truth.

The title of "organic life" includes all the phenomena of living bodies, which are independent of sensation and *voluntary* motion. The principal phenomena expressed by this term are those of digestion, chylification, respiration, sanguification, circulation, secretion, absorption, &c.

The animal existence is one which is joined to the organic, and has a relation with it. It is identified by the faculties of sensation, by which it is liable to be affected by, and motion, by which it is capable of affecting, the external world.

The intellectual existence is joined with the organic and animal existences; it is identified by the faculties of remembrance, association, comparison, inference, &c. Perhaps these faculties are not so distinct as they appear: it is possible to regard them all only as modifications of the first; of this we shall speak at a future time. The *degree* in which these faculties are possessed seems to distinguish men from brutes; rather than the perfect possession of them by the one, and the total absence of them in the other.

My present design is in general to exhibit the state of evidence upon the several topics. If this evidence furnishes a series of satisfactory conclusions which agree with each other, and with other things, the value of the evidence will not be diminished by its being conjoined with the conclusions it supports, even though these last may assume the form of a system, for which I give no pledge: my only pledge is, to make out a few truths if I can.

CHAP. I.—*Maternal Ovum.*

§ 1. THOSE who wish to know of what constituents the textures of animals are formed, may consult the systems of chymistry, in which their analysis, to a certain extent, might be found. But to us, who are just entering upon a different inquiry, chymistry can furnish but little aid; our research is not concerning the proportions of fat, earth, salts, &c.; but it entertains connection with their result: we have not now to consider the visible fabric in its elements; it shall suffice for us to notice, with respect to these elements, their tendencies, and some few of their phenomena which are exhibited under different alliances.

§ 2. There is no distinction more obvious than that between the living and the dead states. If we wish to know in what this difference consists, it will be necessary to express so much of the difference as we are capable of perceiving, trusting afterwards to our inferences for supplying what is further to be desired.

§ 3. As, in the definition of the organic life, the processes of digestion, circulation, respiration, secretion, &c. are said to constitute it; so, in the absence of these, the organic life ceases; this criterion of the difference between the living and the dead states, can be neither overlooked nor doubted. Organs then, during life, in a state of action, at the period of death fall into a condition of rest. Is there no other difference between the living and the dead states, but that the one is matter in motion and the other matter at rest?

§ 4. It must be replied, that the difference, so far as we have traced it, consists in this, viz. that in the living state there is the presence of an efficient cause of these actions, *of a peculiar nature, and giving rise not to mere motion, but to peculiar motions connected with other phenomena,* which it will be our future business to consider: in the dead state there is no *such efficient cause;* if its properties are retained in the textures, its *form* is *inefficient.*

§ 5. That this cause is one which belongs neither to the mechanical nor the chymical constitution of the textures is shewn, to the very utmost extent of observation, by the fact that these processes, characteristic of organic life (before mentioned), cease, while the mechanical arrangement and chymical constitution of the textures remain. In the ordinary instances of death, scepticism may urge, it is possible that some change takes place either in the chymical constitution, or in the material arrangement, which occasions the cessation of the actions. As in a piece of machinery,

the motion of the parts ceases when their arrangement is disturbed, notwithstanding all the causes remain which before produced the motion.

§ 6. The objection is an absurd one: we will, however, remove it by an instance which is not one of ordinary death: arterial blood contains the chemical elements: amputate a limb, wash out the blood, let the textures be carefully preserved, transfuse arterial blood into its proper channels: the phenomena of the living state will not take place, as circulation, secretion, &c. the blood will flow to a certain extent, as in any other dead tubes, until it coagulates.

§ 7. If, however, it were proved that life consists in a modification of chymical or mechanical properties, the phenomena of this modification are so different from the ordinary phenomena of these properties, that they furnish a contra-distinction: and as the phenomena are thus distinct, so also must be the cause by which they are produced; the former therefore would be designated vital phenomena, or the phenomena of life; and the latter, the vital principle, or the principle of life. The nature of the principle is thus put upon the footing of the universal laws of causation; and whatever might be its origin or connections, the same investigation is applicable to it, as a cause peculiarly constituted, whether, indifferently, by a modification of the common or of the chymical properties of matter, or wholly by another class of properties which are essentially connected with neither of these departments.

§ 8. It is not necessary in this place to connect all the processes of organic life with the cause just adverted to, or with that which has been called the vital principle. It is sufficient to indicate a general efficacy which belongs to it, and return to the operations of it which are connected more strictly with our present design.

§ 9. During life, or during the continuance of the cause above spoken of, the identities of the structures are preserved; when this cause ceases to act, the structures are disposed for change, and they gradually run into chymical decomposition. It is then by the influence of the cause called the vital principle that the structures are kept together: this cause ceasing to act, it is the tendency of the textures to disunite, and return to what have been called their elementary constituents.

§ 10. As the constituents of the textures when left to themselves, so far from having any disposition to unite, exhibit clearly the contrary tendency to separate; so the cause of their union, in the living subject, is not to be looked for in their own nature, or their own properties (which are mutually repulsive), but in something different from their chymical elements.

§ 11. As the chymical elements remain united only so long as the principle of life is with them, and separate when the efficacy of this principle is no longer displayed; so we appear warranted to infer, that the vital principle; or the condition of it in which it is capable of the processes of life, is that which *produces* the union of the elements of the textures; since by it alone this union is maintained, and it ceasing, the union is dissolved: than which double

test, in a matter of inference, there can be *no higher proof of causation,* as will hereafter be shewn.

§ 12. This principle, which we do not see, I call inclusively the organic spirit; thus *distinguishing* it from the chymical and material alliances; and for this purpose only, and having expressed how much is meant by the term, there can be no objection to the use of it, provided the distinction it implies be agreeable to truth, which I have begun by endeavouring to prove.

§ 13. In our view of the principles of causation, it was shewn that there is nothing strictly elementary.* We are therefore taught to expect the agency of properties in phenomena, where we are not even acquainted with their effects; that is, we are taught to infer a series of causes which has no end: bodies, compounded of properties, related with the senses; these latter, of others, not related with the senses; and to a great extent we can trace, satisfactorily, as in the present instance, these relations between a visible and an invisible world. Without however examining here what we are to think of the extent of these relations, it shall suffice to have remarked *that* of the spiritual alliance with the animal textures to be in mere conformity with the principles before laid down. Before connecting then the formation of the textures with the agents by which it is said they are formed, it will be proper to inquire a little concerning the origin of the *cause* itself, which appears to have a natural precedence.

§ 14. We distinguish, among others, two modes of the production of an apparently *new form;* one, by perceptible constitution, where the components are brought together and combined, as in the example of the union of an acid and an alkali, and the formation of a neutral salt; and the other, as where a form previously constituted detaches from itself a portion of its own identity, giving rise to a distinct being: the former mode may be called the origin by *constitution,* the latter an origin by *derivation.*

§ 15. If we examine how the spirit of a man *came to be,* we must recur to the first mode, and pursue the history of its formation and growth: if we inquire how it is perpetuated, we shall find strong traces of the latter, and at the same time shall not altogether overlook the former; in other words, we shall find these modes to be mixed in this business, and the examination alluded to belongs to our present subject.

§ 16. The organic spirit is formed like gross substances, viz. by its constituents; if it be asked what these constituents are? it must be replied,

§ 17. The properties by which it is identified, and without which it cannot exist.

§ 18. The organic spirit exists in various forms: in some instances, as in the lowest tribe of animals and vegetables, it displays but little more than a single property, or else a combination of properties subserving to one similar end; that is, it does little more than

* Chapter II.

maintain the connection of an homogeneous structure. As we ascend in the scale of the animal creation, the complexity of the spirit increases, though not in the same ratio as the complexity of the animal and intellectual faculties increases; for the organic spirit of a horse exhibits in its effects as great a complexity, or as many properties, as that of a man.

§ 19. On account of the irregularity adverted to, the laws of the organic spirit cannot be generalized, except in some few points of agreement, and they therefore require to be considered specifically in the several examples. The life of man is the example here chosen, and the only general laws to which it is necessary to remark its subserviency are those universal ones of causation before spoken of.

§ 20. The first sensible origin of man is his existence in the ovum; and it is here that the history of his *perpetuation* must commence.

§ 21. The organic particles of the ovum, life being extinct, follow the fate of those of the other textures; that is, they become separated from each other. The tendency then of the organic particles of the ovum is not to *aggregation*, but to *decomposition:* their aggregation is maintained by life: without life their union cannot be preserved: but for life, their union would not have taken place, they separating when life has ceased.

§ 22. The organic spirit of the ovum has then this property of life, viz. to be competent to produce and maintain the union of its organic particles. It has also other properties of life, although it wants those which are subservient to growth.

§ 23. If the organic particles, which this spirit forms and unites, are homogeneous; or if it performs only one action; then the organic spirit is an identity which has only one relation, and this a mediate relation with our faculties of perception. But if it produces particles which are not homogeneous, and if their arrangement is diversified, then the properties concerned in the formation of this spiritual identity have several relations with our faculties. This is a common distinction in the relations of causes, and it has been before explained. To give a familiar example of it: thus a chymical substance in its state of combination appears to be but one nature; in the state of analysis it exhibits different natures, these were contained in the homogeneous body, but in that state they had no relation direct or mediate with our faculties of perception.

§ 24. The organic spirit of the ovum produces the sensible effects of but few properties, but it has many properties which are *latent*, perhaps tending to influence the organic particles: of these we are imperfectly instructed by facts of the description which follows.

§ 25. An ovum, which at first displays only the property of life, of preserving the integrity of its material alliances, is capable of running through a series of changes, by which the character of its material aggregation is changed; numerous combinations take place, parts become distinct, their arrangement is determined, finally

all the characteristics of the most complicated state of life are manifested. These processes in the crustaceons ova are more conspicuously applicable to my purpose; these ova are detached totally from the parent, and are at this period in the simple condition which has just been remarked, they are afterwards exposed to the operation only of a single external cause, viz. heat, and the spirit begins to manifest its complexity, the textures are elected, evolved, and arranged.

§ 26. The respective causes, corresponding with the individual changes, are not conferred from without, they are therefore inherent in the ovum; when they are not exhibited, as in their earlier stage, their combination prevents an individual recognition, and they are said then to be latent.

§ 27. This state is a predisposition to after-life.

§ 28. The organic spirit of the ovum possesses either all the properties of the organic spirit of the parent, or other properties having a relation with the external causes by which the identical properties of the organic spirit of the ovum are subsequently assumed. This question is not to be discussed here: but the proof of one or other of these alternatives is this, viz. that the ovum becomes, in a general way, which is sufficient for the purpose, the similitude of the original from whence it was derived; that is, a substance nearly homogeneous and destitute of any visible arrangement, is capable of attaining all the complication of the structures, as bones, cartilages, ligaments, membranes, muscles, nerves, arteries, visceral organs, skin, hair, &c. and the same thing obtains with respect to vegetables. Let it be remembered that the tendency of the matter is to *dissolution*, and consequently its parts could never unite but for that which prevents dissolution and counteracts the force of a natural tendency, viz. the organic spirit. This is the antecedent to these visible phenomena; or this is a governing agency, amidst concurring causes; and this it is whose history we are now to trace.

§ 29. It has been said by some, that the primordium of every individual of the human race was contained in Adam, or in first parents, and that the succession of persons has been maintained by an evolution of original seeds. To this opinion I cannot assent, in consideration of the following circumstances:

1. An entire ovum is but the assemblage of a very few organic particles. As the rudiments of procreation hold but a very insignificant proportion to the rudiments of the whole body, so we cannot imagine that a single ovum, which was developed into the first offspring of the primo-genitors, should contain the *identical* elements of an endless perpetuation of the species.

2. It is contrary to analogy to suppose even that the identical embryon of the third, was contained in the first, generation; for the ovum, in its primitive condition, contains none or but very few of the *identical* parts, which make the future animal; these are perpetually changing, and increasing by the processes of growth; and

as the properties of the ovum, when the shape, &c. of the animal are attained, are capable of a wonderful increment of their own nature, it is little better than absurd to refer a series of generations to one ovum, to so diminutive a source, when it appears that every animal is endowed with a capacity of increasing, almost indefinitely, the elements of procreation, as well as those of the structures.

3. The procreative agents, so far from appearing to be possessed in anticipation by a single ovum for all generations, do not appear to be possessed *identically*, that is, such as they were obtained from the progenitors, even for one; for the procreative faculties are not manifest, or exercised, until many years after the formation of all the organs and structures, and must therefore be allowed to be a product mainly attributable to the animal in whom they are considered. So far then as the observation of facts is permitted us, the supposition does not appear to agree with them; and if it is proposed on any other grounds, it is not worthy of consideration. Indeed, it would be as reasonable in every respect to say that all the bones as well as all the seeds of the human race were contained in Adam, or in first parents: the arguments, on both suppositions, as hinted above, might be founded on the same analogies. Other reasons for a contrary opinion upon this point will appear in the detail of my own views, to which I therefore proceed.

§ 30. That the maternal ovum contains all the properties of the original, that is, of the mother, or a predisposition to these properties, appears, as before remarked, from the general similitude which the offspring bears to the parent. The question, whether the properties which at a future time are to produce bones, muscles, &c. are contained in a peculiar combination in the ovum, or whether they are acquired from without, by relations which certain properties in the ovum have with the external influences, is not so easy to settle in regard to the human race; but the fact, that the crustaceous ova are developed by changes which takes place among their own constituents, appears to sanction the former conclusion, which I shall therefore assume to a certain extent for the present, and I trust not farther than is allowable.

§ 31. The condition of the maternal ovum is this: it is a small aggregation of matter, formed by some properties of the organic spirit, and it becomes the receptacle of an organic spirit. This spirit itself is a combination of many properties; these in the condition of the ovum are for the most part *latent*, but they afterwards become causes, and are displayed in effects. These properties in the condition last mentioned, under which they are exhibited, are similar to those possessed by the original. The proof that such latent properties belong to the spirit of the ovum is this, viz.

§ 32. That the processes of *constitution* take place in the progress of the ovum towards fœtal life; *constitution* is no single act, or is not the act of an element, as explained before. There is no bone in the first stage of the existence of an ovum. Blood supplied to *any* organic molecule will not be formed into bone: for this

purpose something else is required, viz. the existence of properties, whose relation with the constituents of blood is to form bone. The same thing is still more clear in the crustaceous ova, as before remarked.

§ 33. A great apparent difficulty may possibly be started in this place: it may be asked how is it possible for so small a body as the ovum to contain so vast a diversity of properties as is thus supposed? We must answer this question by citing as much as we are able to observe of the nature of properties.

§ 34. Matter is constituted by a combination of certain properties. No *one property* is material; but the aggregate of properties is recognized as that which has a well-known relation with our faculties of perception, and which we agree to call matter, just as we agree to call the united existence of an acid and an alkali a natural salt. Now matter itself, in the gross, is said to be infinitely divisible, and yet the individual properties of matter, which are recognized only by a single sense, as its colour or its smell, are constituted by other properties with which we have no perceptive relation at all. (Chap. II. &c.) It may be doubted whether the properties related with smell and vision possess figure; but supposing that properties do possess figure (which is supposing what cannot be invariably true), merely to facilitate our conception of the divisibility of properties, it may be observed (to borrow an illustration) that a substance may continue for a long time to emit an odour sufficient to fill a considerable space, without any sensible diminution of its bulk or weight. The odour existing in the minuter spheres of this extensive space is of the same nature with the whole; the space may be divided into ten millions of spheres, the property of odour in each of these spheres may be infinitely constituted by other properties, yet all these are emitted from a substance which may perhaps weigh only a single grain.

§ 35. If then a property is thus divisible, if the property which resides in the smallest perceptible bulk may be divided into ten millions of portions, and each portion comprising an infinity of constituents, we shall have no difficulty in conceiving how a sufficient number of properties for the future development of the animal may reside in an aggregation of matter, as an ovum, which itself appears to consist only of a few particles.

§ 36. We have said that there is no limit to the diversity of causes, by which the minutest effect is produced, from the necessity of what have been called the *causæ causarum*. It will be allowed, the faculty of vision is as perfect in its kind at a *mere point* of the retina as it is on the whole surface (there are a thousand instances of the same force if this should be denied), now this faculty is made of many properties; some of them are analyzed in our experiments. There are then, confessedly, many properties on a scope of matter not bigger than the point of a needle. Now supposing that these properties, instead of remaining combined and minute, as they are, should have a tendency to separate, and being supplied respectively

with their similitudes, each should aggregate and repeat its own nature, themselves being thus developed, and by force of relations developing a sensible bulk, in correspondence with their own increase. Why this is a parallel to all that we are supposing of the properties possessed by the ovum. We object to its minuteness for the possession of so many properties, and yet it is clear that more properties than we can enumerate in the ovum may exist upon the minutest point of matter; and the reason why in the latter case they are not conspicuous, is precisely the one which explains their concealment in the former, or in the instance of the maternal ovum, viz. that the properties want the processes of growth in order to become conspicuous. This matter is too obvious to require another word in explanation: it may, however, be added, that as much as has been here remarked is agreeable with the whole of our experience of the nature and laws of properties.

§ 37. As the spirit of the maternal ovum, for succeeding generations, has been said not to have been contained in first parents, but to be formed in each *de novo*, the question next to be considered is in what manner it is formed? And now we must recur to a question which has been anticipated. To define it in regard to its present application, we will ask, Is the organic spirit of the ovum *constituted* for the purposes of perpetuation, in the same way in some respects as it was in the first of the species? or is it formed in the way of derivation?

§ 38. To suppose the constitution of the human organic spirit in the primitive way, would most probably involve a long history of changes and accessions, on which, as we understand not spiritual relations, we have no grounds for conjecture. Further, in such an original constitution we cannot but suppose the occurrence of many accidents which would render its identity irregular, much more so than we find it. Upon the whole, it does not appear necessary to preserve a distinct discussion of these questions.

§ 39. The maternal ovum was no more formed in the ovum from which the mother herself was produced, than the bones: it was then produced subsequent even to fœtal life, which furnishes no ova. The maternal ovum is found to have properties correspondent with the properties which belong to all the parts of the mother; the manner in which it is produced in the mother, is the subject of our immediate consideration.

§ 40. The alternatives of the manner in which the spirit is produced which forms the maternal ovum, are the two following: 1st, whether the seat of the formation of the ovum is a point to which every order of structure, or every part in the mother, sends identical properties, which thus reside in the ovum, requiring only the development which they obtain by the processes of nutrition and growth in order to form a new being, which resembles the one from which it was derived, and which is constituted by the possession of the identical properties of the parent? or, 2nd, whether, without any contribution of identical properties from remote structures, the

ovarium exercises *a function*, independent of other seats, of producing a certain aggregate of organic molecules, and of endowing them with properties which are similar to those possessed by the parent, in every seat?

§ 41. In order to settle these alternatives, I devised an experiment which, if it had succeeded, would have been conclusive. The object of the experiment was to preclude the possibility of *identical properties from remote seats in the ovum.* For this purpose, I procured two young rabbits, a male and female, and cut off both their ears. The rabbits attained maturity, grew old and fat, but did not breed. This experiment was repeated with two other rabbits, but it so happened that they did not breed. These experiments are not sufficient to prove that rabbits will not breed when their ears are cut off, but I did not feel disposed to multiply my examples: this therefore is the result, which leaves the question undecided. I can assign no reason for this defect of procreation in these instances, unless that the rabbits did not, with their ears cut off, know each other to be rabbits.* Here it will perhaps be sagaciously observed, there is no need of such a proof as this experiment tends to furnish; for we see human beings variously mutilated, having lost an arm, or a leg, or both arms, or both legs, getting perfect children every day. This is true, but is no parallel to my experiment: for if the father of a child has no arms, the mother has, and either parent can furnish the radicles of resembling structures. If the annals of human procreation, which are tolerably diversified, can furnish any instance in which both parents has lost *both legs, both arms*, or *both ears*, or had *no teeth*, such an instance, if I had been acquainted with it, would have superseded the necessity of my experiment; which, as it failed, the subject to which it refers remains to be discussed upon the few imperfect data which are currently known.

§ 42. Every part of the mother possesses its organic spirit; every muscle, every bone, every nerve, every artery, every particle, have their organic spirit; by it they are produced, maintained, and governed; all these are possessed likewise by the ovum. Now these parts of the ~~en[illegible]~~ entire organic spirit are modified in their several seats; that is, where they produce different phenomena: and their seats are, respectively, fixed with precision; or else we should every now and then find toes in the stomach, nails on the forehead, liver in the hands, kidneys on the face, &c. The parts then of the spirit, or its several modifications, have their respective seats.

* Let it be borne in mind in the subsequent discussion that only *one result* of this experiment can be conclusive: that is, if the offspring should be deficient in ears, it will prove the derivation of the ovum from the precise seats of properties in the mother; if the offspring should possess ears, they may in like manner *be obtained by derivation* from those undeveloped properties which exist in amputated surfaces and afterwards are exhibited by the production of new growths. For the elucidatiou of this note the chapter on Growth is to be consulted.

§ 43. The seats of properties are determined by spiritual relations, for at first the existence of properties is not manifested; they afterwards assume their identities and seats, giving rise to aggregations and arrangement of matter; which change is accomplished by the causes by which the properties producing visible effects are governed. When a modification of the organic spirit has assumed its sphere, it exerts a function; one of secretion, for example. Now this function has so many properties as are determined by its relations with those other spiritual properties with which it co-exists.

§ 44. The precise nature of the function which produces the secretion, is determined by a causation between the parts of the spirit, which we can in no instance understand, because we are in no instance acquainted with the relations it involves. The secretion will be according to the function.

§ 45. Every secretion is *endowed* with precise properties; and the same only can be said of any other production, which we may or may not call a secretion. How these properties precisely, and no others, came to be assembled, will be as difficult to pronounce upon in one case as in another, because in all cases there are antecedent processes of causation, of which we are totally uninformed; and it is sufficient for the present thus to shew the correspondence of these processes with the general order of causation which they also observe.

§ 46. Thus then the product of a function may possess chymical properties, and matter of a common kind, and latent constituents of life which may originate new forms; such a function as this is displayed even by the kidneys, and sometimes by the skin, &c. whose secretions generate animalcules. In each part the function is precise, and not to be explained but by the knowledge of antecedent processes.

§ 47. So in the ovarium, the function of this part is to produce ova. These ova are only a determinate constitution, the effect of a determinate function, governed by processes of causation, obeying spiritual relations, which are antecedent.

§ 48. These ova, like any other product of a process of causation, have their identities, their causes, their relations, their properties, &c. some of which we shall endeavour to develop.

§ 49. The only properties of the maternal ovum, before its elimination from the ovarium, which are manifested in effects, are those which produce and maintain a few organic particles.

§ 50. The latent properties of the ovum, in this condition, are those which correspond with the parts of the organic spirit of the mother; and there is so ready a communication between them, that is, between the properties of the mother and those of the ovum, that we are inclined to suspect, as stated in our first alternative, that the formation of the organic spirit of the ovum is by a derivation from all the parts of the mother, and that the confluence of all the organic properties of the mother to the ovarium is an

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established function, either regular or occasional; rather than that the ovum is a local production, independent of the diffused maternal parts. It is difficult, without admitting such a supposition, to reconcile facts of the following kind:

1st. Local hereditary diseases. Thus a mother may be affected with phthisis pulmonalis (a disease perhaps not before known in her family): this local tendency existing in the lungs (for such local tendency is necessary to the disease), is participated in by the ovum, and the subject which is matured from it may also have, at some period of its life, ulceration of the lungs.

2nd. The same may be said of calculous disorders, of gout, of cancer, &c.

3rd. I knew a case in point of the following kind: a woman was constantly afflicted with intense pain in the head: it continued for some months, occasionally so severe as to produce a state of stupefaction, sometimes to threaten a loss of intellect, and was mitigated by none of the means employed for its relief. *At this time she was delivered of an acephalous fœtus.* The pain in the head afterwards recurred irregularly, and with less violence; she then had a child naturally formed, but subject to frequent convulsions, which threatened its life; and at about the third year, at which time my acquaintance with the history ceases, a fatuity is remarked which renders doubtful the future possession of good intellectual faculties.

§ 51. Now these circumstances do not afford absolute proof on the point in question; for the latent properties producing the hereditary diseases, might have been formed in that which was to constitute the *ovum* of the offspring, as well as in that which was to constitute the lungs, the brain, the kidneys, &c.; and these formations might have been synchronous and independent in the ovum from which the mother was developed. The case of disorder of the head might have exhibited a coincidence only, and not a process of causation. But, if we allow it not proved, that the properties of the ovum are *derived* from a corresponding seat of properties in the mother by these facts, we must admit that the ovum, if independently formed, is liable to be modified by the organic spirit of the mother existing remotely; because, diseases produced by accidents, or by habits of living, have been participated in by the offspring, in which case the independent predispositions of synchronous formation seem to be precluded. Thus mania has been perpetuated, or has been introduced into a family, where its origin was referable to accident or habit; thus also gout, and consumption, which have originated in habits of life, have been transmitted to offsprings who have not equally subjected themselves to the same exciting causes. The disease in these instances was created subsequently to the formation of the ovum.

§ 52. In addition to these testimonies, it may also be observed, that the ovum has no life of its own capable of maintaining its

texture; that when the parent dies the decomposition which follows is universal, and the ovum shews no more the possession of an independent principle than a portion of muscle or skin. As, however, from the death of other parts, the circulation ceases, this remark is less conclusive than it might have been if deduced from experiments in which this objection would be fairly obviated. From however a just estimate of this class of facts, we are warranted in presuming that

§ 53. A communication subsists between the properties of the organic spirit of the ovum and the diffused one, occupying the several seats belonging to the mother, and that by this intercourse the former is liable to be modified. We appear warranted in presuming thus much, although it should be refused to admit the regular confluences of all parts of the maternal spirit to the ovum, in the same manner as properties of a defined number and nature are assembled in the other parts by laws equally mysterious; as, for example, the properties which constitute a sense. This latter opinion, although I say it is not proved, I consider as probable,* and shall therefore bestow a few paragraphs in its further illustration.

§ 54. To suppose a centre which is related with all parts of the body, has in it nothing monstrous, nor, as above hinted, does it want the support of analogy. The faculty of speech and the agents of articulation are related with all the passions, with all the operations of the understanding; they are even more extensively related, and the influences they obtain are derived from one entire system, of the properties of which no part of the material fabric is wholly destitute. Thus, the eye may witness a shipwrick (or any other catastrophe); hope, anxiety, fear, horror, &c. may be successively occasioned by this instance of vision: and as the feelings are modified, so also may be the voice and speech; one while an exclamation of terror, then a recital of the chances or possibilities of escape, then an exclamation of horror at the conclusion of the tragedy, with an ensuing train of feelings, all of which might be expressed by the voice. The catastrophe, or spectacle, being finished, the mind might fall into a series of reflections perhaps upon the precarious existence of man; and the train of actions in which the organs of speech have been thus engaged, may terminate in a disquisition upon moral conduct, and the reasonableness of our expectations of a future state. The same thing in effect may happen, though the operations should have been commenced by the excitement of any other sense. Thus the organs of the voice form a centre at which the variations of an extensive system *may meet*, and by which the minutest of these variations, however remote its origin, may be expressed. The same thing happens with regard to the brain: and every organ *is a centre*, whose

* The additional alternative, expressed in the note at page 72, is to be taken into the account, and regarded as making only a modification of this inference.

function is not perfected in itself, but by remote influences and distant relations. It does not appear therefore assuming too much in the instance before us, to admit the possibility that the organic spirit of the ovum is formed, maintained, or modified, by a confluence, regular or occasional, of the spiritual properties of the mother, existing in different seats, and which properties, as may be demonstrated, are possessed also by the ovum. I have stated the evidence which refers to this topic, or as much of it as is apparent to me. I should be sorry to assume more than is justified by it. I will therefore state, of the condition of the maternal ovum, as much as appears to have been rendered probable.

1st. That the ovum, before its elimination from the ovarium, contains properties which correspond with those which belong to the mother.

2nd. That these properties are so combined, that they are, in this stage, latent.

3rd. But that these properties constitute the predisposition to future effects.

4th. That the properties of the ovum are liable to be influenced by communicating with those of the mother.

5th. That the life of the ovum is not independent of that of the mother in viviparous animals.

6th. That the matter of the ovum is an aggregation of no very complicated kind, because only a few of the properties of the organic spirit are exercised in this stage of its existence.

It is affirmed, that the ovum is not perpetuated by evolution: but it is not decided whether the ovum is formed by derivation from all parts of the mother, or whether the function of the ovarium is to produce resembling properties independently of their diffused existence in the several seats; had the experiment before detailed succeeded, it would have gone some way towards settling this point; in the mean time the former alternative is preferred, for the reasons which have been just assigned.

Among other points, still doubtful, it is not proved also with certainty, whether the osseous spirit, for example (or any other), exists in the ovum, or whether the ovum possesses only properties which determine the future existence of an osseous spirit, through a series of processes and preparatory relations: if the former is true, then the ovum is not the fœtus by reason of *peculiar combinations* of its properties; if the latter, then it is for want of progressive causation. This however is a question which it will be hereafter attempted to settle.

Thus much for the present for the organic spirit of the ovum, previous to its escape from the ovarinm. The order of our considerations suggests, that we should next speak of it in its fecundated state.

CHAP. II.—*Fecundated Ovum.*

§ 1. THE *maternal ovum* is constituted for the preservation of its identity in this state: and this identity is maintained, 1st, as long as life continues to reside in it; or, 2d, until it receives an extraneous influence of a peculiar kind.

§ 2. This extraneous influence being obtained, *sub coitú*, that which was the maternal ovum becomes the fecundated ovum; and instead of a constitution disposed to preserve its present identity, it is made one, disposed for change.

§ 3. It has been matter of inquiry among naturalists whether an actual contact of the ovum with séminal fluid is necessary for its fecundation? or, whether the communication of an aura subtilis, from this fluid, to the ovum, is sufficient for the same purpose? As is usual in questions of no importance, many experiments have been made with a view to the decision of these questions. The experiments are not worth comparing: the *principal* facts relating to the question are the two following: 1st, that an ovum, in the human subject for example, is fecundated in the ovarium, as in the case of extra uterine fœtuses; to which seat, it appears improbable, from the structure of the parts, that the gross seminal fluid should penetrate. 2nd, That the ova of fishes are fecundated without coition by mere contact of male semen. If the first fact indicates that the ovum is fecundated without seminal contact, or by an emanation of its properties, or aura subtilis, the second fact does not refute this conjecture, because, though an actual contact may commonly take place, yet the properties which are efficient in the result of this contact may be separable from the fluid to which they belonged; or may be the emanating properties, or aura subtilis just spoken of. If the argument were discussed minutely, much might be urged on both sides: such a discussion is however superfluous, because, as before hinted, the question itself is one of very little importance; for the relation of the ovum is not with a few gelatinous particles, but with the spirit or vital properties of which the visible fluid is the mere vehicle or medium. In this point of view, as the fluid itself can have no *efficacy*, whether it does, or does not *touch* the ovum; it seems, on this account, scarcely worth while to bestow a grain of ingenuity in settling the alternatives.

§ 4. The properties of the maternal ovum, receiving the extraneous influence just mentioned, commence the processes which terminate in the establishment of fœtal life. As the maternal ovum was indisposed for these processes previously to fecundation, so they must be considered as the result of a *constitution* which takes place in the ovum.

§ 5. As it is proved that the material and chymical parts of the ovum are not the governing but the governed,* so the constitution which takes place, *sub coitú,* and which produces the changes hinted at, respects the properties of the *organic spirit* of the ovum, and not its material alliances.

§ 6. It has been said that the properties of the maternal ovum correspond either identically, or predisponently, with those of the mother: the proofs of which are chiefly rested upon the following description of facts:

1st. The offspring of a black man and a white woman is a mulatto.

2nd. The offspring of a horse and an ass is a mule, &c. Examples of this kind are familiar and the law obtains as far as the procreative intercourse between varieties of the same species is known to take place.

§ 7. Hence it appears, that as much as has been remarked of the properties of the maternal ovum may also be said of the seminal constitution, viz. that this likewise contains an organic spirit; that this organic spirit is, like the maternal ovum, indisposed for the changes which end in fœtal life; that it exhibits in its material aggregation but few properties; that it has many latent ones, which correspond either identically, or predisponently, with those of the subject in which it resides; that these latent properties are in peculiar combination, &c. A parity of laws may be remarked between the seminal production and the maternal ovum, because these laws are deduced, with but few exceptions, and those of no great importance, from the same facts.

§ 8. But this subject, viz. the fecundated ovum, brings us to a question which, in speaking of the maternal ovum, it would have been anticipating the subject to have discussed fully. The question is, whether the *identical organic properties* of the parent reside in the ovum? or, whether its properties are only a predisposition to those of the mother, existing in the several structures? The same question, in the other case, may be tranferred to the cause of fecundation.

§ 9. This question must be determined by our principles of causation. The properties, whether of the maternal ovum, or of the seminal fluid, never singly commence the processes which end in fœtal life. It appears, therefore, probable that the procreative rudiments, respectively, furnish only one stage of predisposition towards the properties which form bone, muscle, &c.; but

* Book Second, Chapter I.

this is not to be positively asserted, because the inactivity of these properties may be explained by a peculiar state of combination, which it may be one effect of fecundation to dissolve.

§ 10. If the properties contained in the maternal ovum and those of the cause of fecundation were precisely the same, it is obvious that no change, save that of increment, could result from their combination. But other changes do result from it, and those of the most complicated kind: it is therefore equally obvious that a condition of these rudiments takes place upon their union, which was not previous to their union, and that this process is one of causation, which has been said to be the combination of differentials; or, in other words, something is supplied to the ovum which it *wanted*, to commence the processes which end in fœtal life; and something is supplied by the ovum to the seminal matter, which it wanted in order to commence the same processes, these, singly, not being constituted for such an end.

§ 11. Thus then we see that in order to exhibit the state of fœtal life, at which period, and subsequently, the resemblance of properties to those of the parent is also exhibited, it is necessary that something different should mutually be supplied. Whether this difference, this process of constitution, belongs to all the parts of the spirit, or only to some of them, is a question to be examined.

§ 12. As the offspring from a male and female, of varieties of a species, is found to be modified in all its parts; as the development of the bones, &c. in the mule, is not the same as either in the horse or in the ass; as every difference in the progenitors is expressed by a corresponding difference or modification in the offspring; and as progressive causation in a body which is not exposed to adequate external causes, consists only in the development or changes of combinations of properties *already possessed*, or latent; so we must conclude that the procreative rudiments on either side contain all the properties of their originals; and that as the offspring affords evidence of the possession of no other properties, but those which do agree with those of the originals, so we must consider the change which occurs in the ovum, *sub coitû*, as the effect of the combination of the differentials, which in every case appear to a greater or lesser extent in the progenitors.

§ 13. It is then that process of constitution which takes place in the ovum by the mixture of the properties of its organic spirit with those of the male, which gives activity to the former, and makes them commence the processes which terminate in fœtal life. But whether all the differentials concur in this effect, or whether the activity of the ovum is produced only by a relation of agency subsisting between the properties agreeing in either sex with the generative organs (which are perhaps the only fixed and constant differentials), is a point which cannot be decided, because the difference is not confined to these organs, but might pervade (irregularly, in the several examples) all parts of the constitutions, respectively, of the male and female.

§ 14. There are some properties of the organic spirit (indeed the principal part of them), which are common both to the male and female: these may be called perfect resemblances: there are others which are different, or their efficient union is different, though bearing a resemblance in some respects; and there are others which bear no obvious similitude. These properties in the parents reside, according to the restrictions and alternatives before proposed, one set in the maternal ovum, and the other in the seminal fluid, and it is in these productions that we are now called upon to consider them.

§ 15. The instances of the first, viz. those of perfect resemblance, are found in the properties which develop common identical substances, as bone, brain, muscle, &c. in which the properties derived from both parents agree perfectly to a certain extent; those of the second, viz. where there is agreement in a general character, but difference in some respects; as in the allied properties with the common ones just mentioned, which *modify* the development of bone, brain, muscle, &c.; those of the third, viz. properties that are totally differential, as those which develop the organs of generation and those which supply, on either side, the seeds of hereditary disease.

§ 16. These properties on both sides are related according to spiritual laws. But, in general agreement with the laws of causation, they may be classed under three heads: 1st, properties of aggregation: these include the perfect resemblances; 2nd, properties of constitution, as where differentials unite and modify each other; and, 3rd, properties differential, holding with regard to the others neither the relation of aggregation nor that of constitution, but which preserve singly their own natures.

§ 17. It has been said that these rudiments of the future animal contain the properties which afterwards produce bone, &c. that is, that these properties are not conferred from without. But a question was started at the same time, viz. whether these are precisely the properties which are to form bone, &c. or whether they are only predisponent, and made perfect by external relations. It was also said the former would be presumed upon to a certain extent, and I now repeat more fully the ground of that presumption. The fecundated ovum of an oviparous animal is consigned perhaps to a dunghill or the sand; it obtains here no accession of properties except *heat*, and a series of internal changes take place, which terminate in the formation of the textures, &c. of the fœtus, which are, in their nature, nearly those of the adult. Now if a property to form muscle, another skin, another bone, another stomach, &c. existed merely in a *predisponent state* in the *fecundated ovum;* that is, not the *perfect property*, a deficient identity, this one cause, viz. heat, could not supply to all the deficient properties those differentials, agreeing in number, which would render each perfect. For this would be to suppose what indeed is possible according to the laws of causation, but of which we have no single instance; it would be to suppose that

caloric is capable of an analysis, by combination with an ovum, into a thousand constituent properties, each of which made its specific constitution. But we cannot indulge this supposition to any extent, because we find that instead of being broken down into all those constituents by which, according to our principle of causation, it *would cease to be heat;* instead of this, we find that it pervades all parts in its *own* form, and has no other perceptible agency than that of increasing the temperature of the ovum, thus operating by a general relation, and preserving its entire nature, and not by a relation subsisting between its analysed properties and those of the ovum.

§ 18. But these proofs being, as thus stated, not unexceptionable, even with respect to our laws of causation, it is right before we admit an inference from them to scrutinize the matter a little deeper. It is said in the last paragraph that heat cannot preserve its own identity, and produce a great variety of effects by a true process of causation; that is, by supplying the respective causes which are necessary to *different effects.* But this observation holds good only of the operation of heat upon substances which preserve their identity, or which maintain the unity of their constitution under its influence; in such, their nature is still preserved, their temperature only is raised, and is not applicable to compound substances, or those disposed to separate their constituents, among which the ovum may be reckoned as one; in these latter, heat, without ceasing to be recognizable, may have several relations with constituents, and produce several effects. Thus, as familiar examples, heat may deliquate wax, which will still remain the same in constitution, though rendered fluid by its combination with heat; or it may fuse different metals, or ignite a combustible substance, or deprive a fluid apparently homogeneous of its spirit, or its oil, &c.; that is, it will afford to each of these substances (which are dissimilar) an agent by which they are respectively modified. In fewer words, as long as heat preserves its own nature, the diversity of its effects result, not from the analysis of its own constituents, but from the superaddition of one common property to several properties. The relations of heat are various, but in an homogeneous substance, or on one neither analysed nor divisible, it produces only a single effect, which is to raise its temperature. As the question concerning the ovum is, whether the properties in it, which are subsequently to form the textures, are pre-disponent to, or identical with, those properties which do form the textures, as this is the present question, it appears that the argument cited in the last paragraph is insufficient to decide it, because heat still retaining its own nature, may supply to diversified pre-disponent properties of the ovum that in which they are all deficient, in order to become the identical ones of the textures.

§ 19. As the question is not determined by these facts, and as its determination appears to be of some importance, it is proper to recollect facts of another kind, which are also related with the

question, in the hope of reflecting upon it some additional light. The temperature of an egg may be raised in a few minutes to the same degree as that which it attains during any period of incubation; and yet none of those formations, as bone, muscle, membrane, &c. will take place, which happen eventually. If the properties of the ovum were predisponent, waiting each for a cause which would perfect their identities, it would appear that each being supplied with this cause, should then be in a condition for commencing the operations which terminate in fœtal existence; it appears that this should be the case, if the properties did not act because they were deficient identities, that is, deficient in regard to the purpose which they ultimately accomplish; and if heat, which, so far as we know, has no other varieties but those of degree, perfected these identities, then the temperature of incubation once attained, the properties should require nothing further in order to exert themselves to the end of fœtal existence.

§ 20. But this is not the fact, for a continuation of heat is necessary to the end of fœtal existence; from which it appears warrantable to infer, that heat does not operate on individual properties by supplying a cause, in which they were deficient, in the way of true or individual causation, but by continuing an influence which maintains the series of processes which take place between the properties which are inherent in the ovum.

§ 21. Thus then, in consideration of these preceding proofs, it may be presumed as probable that all the properties of the future animal are possessed by the ovum; that its changes are those of combinations, among these properties, inherent processes of causation, which we are further to consider.

§ 22. The maternal ovum by fecundation is advanced into the second stage of pre-disposition* towards fœtal life. Its latent properties are increased by the acquisition of the differentials spoken of (at § 11, 12, 13, &c.), and its acting properties are also increased by the change of combination which the properties of its organic spirit undergo.

§ 23. The cause of fecundation makes the *latent* properties of of the maternal ovum active; it unites its own properties with them, and they proceed in a series of changes according to their spiritual relations.

§ 24. We can remark nothing further of these spiritual relations than has been already remarked at § 15, where they are reduced to common principles of causation, on the truth of which they are rested. But although we do not know all the agencies which are involved in a single spiritual process, yet we are able to infer some changes which display themselves in the visible alliances; our business will be to trace these changes, making such inferences.

§ 25. The escape of the ovum from the ovarium is probably

* This pre-disposition refers principally to future internal changes by properties possessed.

the effect of its expansion, by which the membrane which confines it is ruptured. An expansion, *sub coitû*, may happen, from the general determination to the uterine system at this time, and a more particular determination to the ovum itself may be supposed, in agreement with the theory before suggested, viz. that, *sub coitû*, the semen of the male and the maternal ovum acquire, as points of confluence, properties from every seat in the structure of the parents. It is not supposed that these resembling or radical properties have a material bulk, by the addition of which to the ovum it might be expanded; it is, in agreement with this theory, conjectured only, that, as in other instances of spiritual determination, as in cases of sympathetic irritation, &c. an increased determination of fluids succeeds to that of the spiritual properties. But whether the ovum escapes by an expansion which ruptures its capsule, or in any other way, is for the present purpose of very little consequence. Its escape is accomplished by an act, or change, of *vital properties*, on the part either of the maternal contiguous structure or of the ovum itself; since the same cause, viz. that of fecundation, would produce no escape of an ovum in the dead subject.

§ 26. The ovum next passes into the uterus: which we may imagine to result from the exercise of a faculty of contraction possessed by the Fallopian tubes, propelling it to its destination. We have no reason to think that this journey is one which the ovum itself has wit enough to perform, seeing that it was never instructed of the road, and has not yet acquired its travelling members, whether by wings, legs, fins, on horseback, or in a mail-coach. So much for these matters: it is enough that this act too is one of vitality. It is a function of the uterus to prepare a membrane for the reception of the ovum, which is very civil on the part of the uterus, but is nothing to us at present. It may however be remarked, that this formation of a membrane is another result of the *determination* just spoken of, and exemplifies a common ending of determination, in secretion. Our present business is with the *growth* of the ovum.

§ 27. The ovum, while it is yet an homogeneous aggregation of animal substance, destitute of any intelligible arrangement, attaches itself to the uterus in such a manner as to obtain blood or some other fluid: and this forms another epoch in the causation which terminates in fœtal life.

§ 28. Blood supplied to a dead ovum will not lead to the formation of the textures, nor produce any change in it except that perhaps of making it contain a little blood: and yet the organization of the ovum might be preserved, so far as it is visible (the best analogous example will be found in the crustaceous ova, &c.) It is then, as demonstrated before in another way, the principle of life, or the organic spirit, which leads to those changes, by which the textures, &c. are formed.

§ 29. Nor are the properties of the spirit gradually conferred upon the ovum by an intercourse of circulation, &c. which obtains

in the uterus (supposing the ovum to be a mere nidus of no specific properties, capable only of inheriting what is imparted to it), for then the placenta would stand a good chance of being the fœtus, and a polypus would inevitably put in for the same honour. Besides, the properties of the *cause of fecundation* are found to be conferred upon the ovum, which are alone sufficient to establish its character as something more than a mere nidus, into which the properties which it afterwards exhibits are gradually transfused; for the intercourse between the ovum and the male has ceased with the act of fecundation.

§ 30. Having now to speak of the influence which the spirit exerts on the grosser materials of the ovum, in the course of its progress to the next stage of its existence, it is proper that we should examine, in the first place, by what kind of relation spirit is able to produce those effects upon matter which have been all along attributed to it.

§ 31. The spirit has been said to be identified by its properties, by the causes which make it, and which then extend their operations to things subjected to them, and with which they are allied. We will first connect the question with some general instances of constitution, of which process the one we are considering is, among others, an example. Why does the ink with which I write adhere to the paper, and why would it not adhere to it if the paper were oiled? Why does an acid combine with an alkali and make a neutral salt? Why do vegetables derive nourishment from the earth and not from stones? Why does the needle follow the loadstone, or a man feed upon beef? It must be answered, from the force of causes. All these are effects, to which causes impel; existence, forcing existence. But the *name* of this process will be inquired for: and surely it will be said the mode of causation is not the same in this confusion of examples. We will return to the examples and ascertain this point.

§ 32. Why does the ink adhere to the paper, &c.? it will be said, by an attraction of some sort or other; and when it is oiled why does the ink run off? because there is no attraction, but rather a repulsion; and why does an acid unite with an alkali, &c.? because there is an attraction among the minute particles, so that they are intermixed, past individual recognition. And the other instances, the loadstone and the needle, and the man and the beef, &c.? attraction, it will be replied. And what is this attraction? a tendency among substances *to unite*, of which there are various degrees and modes; but attraction is only one word, and expresses this tendency to unite.

§ 33. Is this *attraction*, this tendency of things to contact, mixture, *union*, &c. an identical principle; is it the same in all instances? Why, truly, no: things that are joined together agree, however different they might be else, in being joined together; so far the effect is alike. So all things in the world *exist;* but because they have this quality, or effect, in common, it does not follow that all the

instances of existence are the same, or that existence in this case, or junction in the other, are precisely the same, or produced by the same causes, in the several examples.

§ 34. But, so far as the effect is common, the instances, however various their other properties might be, will be found to have some common cause. Thus, a horse *exists*, and so does a tree; but the causes which make the existence of the horse are not those which make the existence of the tree; they are both examples of existence, and the causes which produce mere existence are the same; that is, they are in both *existences*. The same may be said of the union of substances: different substances furnish alike instances of the union of substances. If it be asked what is there in common in the cause of union? it must be replied, a property in the things united, the force of which is to produce their union. As the effect, viz. an *union* of substances, is common in all the examples, so also must the cause of *the common effect* be in all cases *identical*. In opposition to this view, it may be urged, if the principle of union is identical in all cases, *election* among substances is precluded, whereas the fact is otherwise; for the substances which do unite are found to entertain, with respect to each other, a particular and not a common or general relation. From this particular relation may be explained, why a property, to a certain extent identical, in all the instances of union, gives rise to examples of specific election. The property which produces the union of substances is no more elementary than any other agent, or form of existence, but, like every thing else, is constituted; one reason then why some substances are disposed to unite with others, but not with all, is that the causes of union exist variously in substances, and the principle of union is thus formed only when the agreement of its causes contained in the substances respectively subsists, so as to identify the property, by supplying its causes in a way conformable with the universal law of causation. Another reason why some substances are disposed to unite with others, and not with all, may be found in the modification to which the causes of union, existing in different substances, are liable in common with all other causes. Hence it appears that the property of union among substances is identical, so far as the effect is common; that the difference of the principle is expressed in the obvious modifications illustrated in the examples; that the specific elections among substances depend first upon the concurrence of the causes contained in the substances to form the common property of union; and, second, upon a similar agreement or concurrence of causes, when these causes are modified by allied agents, resulting from particular and more complex relations.

§ 35. The varieties or modifications of the principle of union are grossly classed in books under the titles, " gravitation, simple attraction, attraction of cohesion, &c." But the varieties, or modifications of identity in the causes of union, which are included in this classification, are perhaps endless. The chymists have indicated another class of these uniting agencies, agreeing with another

class of substances which appears to differ from the last, principally in being of a more minute and intimate kind: they denote this class by the term "*affinity*."

§ 36. Thus far the words attraction, affinity, &c. are applied only to substances which possess all, or some of the properties by which matter is recognized. But properties, not known as material or falling under the classes of chymistry, are capable of modifying each other (which is the best test of a perfect union among substances); and this is no more than we observe even of chymical substances, for in them properties modify each other, which are neither tangible, visible, &c. nor endowed with any faculty, by which the belief of a material presence is made to arise, as among unions of the gaseous or other peculiar properties, which are superadded to the material substances of chymistry.

§ 37. But, to avoid a cavil about words, we will not say that these properties mix, unite, or combine; words that may be said to apply only to things that are extended; but we will merely say what we find to be the case, viz. that properties, different forms of existence, may modify each other, and if the terms, "the union of these properties, their combinations, &c." should be hereafter used, it is now defined upon what conditions, and they must be allowed to pass by favour, they being founded upon an analogy which in some respects may be thought not unexceptionable. To return then to our affinities.

§ 38. Among other relations, properties have one with matter, by which matter tends to an union with properties: and this it may do though already restrained by some power of union, provided the last be the weakest, as we say. This law is illustrated by a thousand instances in chymistry; it is also illustrated by the phenomena of magnetism; it is also illustrated in animal processes, of which one example will suffice. The living kidney produces urine from the blood, while the dead kidney *will not* by any force of injection of blood into its vessels, although its texture is preserved, and its chymical constitution is not yet decomposed. In the animal department, I call the properties hinted at, for the sake of distinction, *spiritual properties*, and their exertion in such instances an act of affinity.

§ 39. The evidence of the resemblance of such an act of affinity to those displayed in chymistry, is found not only in their apparent analogy (with which alone we ought to be satisfied), but it is also furnished *a priori*. The act in all instances is determined by latent causes of union or separation, by which the relation is fixed. These causes may differ, and the relation will be modified. Having stated the grounds upon which the term affinity is employed, and what is meant by it, we are next to trace the processes which are assigned to its agency.

§ 40. Fecundation, it has been said, disposes the properties of the ovum to be *active*. These properties have been divided (at § 14) into three classes. This classification was made, as comprehending

the relation between the maternal and the fecundating properties, and as they exist and act so are the textures developed.

§ 41. The identical properties of life afterwards manifested have been shewn to exist in the ovum. As these properties do not suddenly form the textures they affect, though they should be perfectly supplied with the only sensible material, viz. blood, so must they undergo previous changes among themselves. The relations between these spiritual properties must be complied with in the first place, their sphere of existence settled, their identities assumed, in agreement with their proper function, which they then begin to exert.

§ 42. It follows from the last paragraph, that the properties which are to form the structures have not in the ovum the same individual seats, or spheres, as those in which they subsequently operate. It follows, that they *gradually* assume their spheres, in consequence of catenated processes of causation, which are internal, and commenced by the influence of the cause of fecundation.

§ 43. Properties having assumed their spheres, their affinity with matter, which has been defined, and proved in many places, and among others at § 8, 4, 10, &c. Book 2, Chap. i., begins to be exerted.

§ 44. The parts of the spirit in their respective spheres, by the affinity mentioned, collect and aggregate materials according to the nature and amount of the properties which compose them; every particle of matter laid down has a property of the spirit whose sphere is in correspondence with its size.

§ 45. The formation of the textures is not at once a perfect process, which must happen (as the textures are governed by the spirit) from the preparatory changes of the organic life. As these latter are modified, so the textures will be adopted: thus, the speck in a partially incubated egg cannot at first or for some days be recognized as the heart; even when it has become a punctum saliens, its analogy to the perfect heart does but partially appear: thus, also, the formation of cartilage precedes the formation of bone in the same place, &c.

§ 46. Now if these conversions are said to arise from different *functions* of the vessels, I would ask the meaning of the expression, I would ask in what a variety of function in any set of vessels consists? or, what is the *cause* of that variety? Why, truly, it will be found in the principle which animates them, for without this principle they are no agents; they can do nothing; nay, so far from accomplishing further processes of growth, the stage of organization already attained is dissolved; the textures, so far from aggregating or producing changes tending to the perfection of the structures, separate in all their parts, and fall into decay.

§ 47. The properties of the organic spirit determine, by the affinity above-mentioned, what shall be its chymical and material alliances. These properties then inhere and unite with the organic particles, forming in conjunction another identity.

§ 48. As the materials admit of being influenced through the medium of the organic spirit, so the spirit itself, as will hereafter

appear, admits of being influenced through the medium of the material alliances. It is difficult to say when the properties of the spirit are changed by this latter mode; but we may infer that the conjoined result, the identity mentioned in the last paragraph, always suffers from the agency of a cause whose direct relation is with either. This matter will in another place be more fully stated.

§ 49. What the precise order of the formation of the parts of the ovum is, cannot be asserted; but of this we may be assured, that there is always a perfect agreement in the *acting properties:* for example, a large blood-vessel would not be suddenly formed, filled with blood, set in brisk motion by a vis a tergo, before such a continuity of tube was established, as to provide against its extravasation.

§ 50. The gradual formation of the textures corresponds with the gradual development of the acting properties: the organization already constructed concurs with the properties of life, but is not itself productive of an increase of organization. It has been attempted by some to explain the organization of a fœtus, by supposing originally some such simple matter as a tube containing a fluid and situated in a bed of some sort of jelly, or any thing else, without the inheritance of any of those peculiar properties which constitute life.

§ 51. We will allow the existence of such a tube, we will even suppose it to be organized, no matter how; we will even grant that it contains blood, no matter from whence derived; we will even allow that it has a faculty of pulsation, without being scrupulous about how it came by this faculty of pulsation; we will grant an apparatus of this sort, and then I would ask what is it capable of doing? Why simply this: if the tube is open at both ends, it would, by its faculty of contraction, very readily and at once expel the blood it contains, and as no source is imagined by which more blood is poured into it, there is an end of the business; or, if more blood is poured into it, why its faculty of contraction will expel it, and the ends of its operations are to receive, and to expel. But supposing that the tube is closed at one end? If the faculty of contraction were not strong enough to rupture the tube (by which it would be in the condition just described), why then the resistance would overcome the faculty of contraction, and the advantage of this postulatum would be entirely lost, which would be a great pity, inasmuch as the future fœtus would remain a mere tube with some coagulated blood in it; and, as all such things independent of a vital principle have a great tendency to decomposition, our pulsating tube, blood and all, would stand a very good chance of returning to its elementary dust, before it would have made any progress in the work of fœtalization. And as the argument would not be improved by supposing five hundred such tubes, instead of one, which would be supposing as much as we reasonably can suppose, I say, as the multiplication of tubes does not improve the force of the argument, we ought to trouble ourselves no further about it.

§ 52. But if it should still be required to shew that the growth of the fœtus is not a mere development of the same system of organization existing in miniature as that which is afterwards manifested, if it should be required to prove this, we shall not be disappointed if we rest the proof on the following grounds. The offspring in every instance of connection between varieties of a species partakes as much of the organization of the male as of the female. How, I would ask, comes this mixture of organization? There is no union of organization between the maternal ovum and the cause of fecundation; and if there were such an union, the mere textures, independent of a principle of life, on either side, would tend to decomposition. So that it is necessary we should admit the organization, which resembles in the offspring that of the male progenitor at least, to be accomplished by the force of properties which are distinct from organization. Further, there is no apparent nucleus of organization in the first stages of the human fœtus; it is a mere cloud: and if there is *supposed organization* here, it will scarcely be supposed in the male semen; and if there were organization in both, it would be altogether inefficient, but for the government of the properties of life. Enough of this.

§ 53. The agreement or harmony spoken of (at § 49) will be more happy in its success, and less objectionable, by reason that there is nothing in it, no agency supposed, which has not been demonstrated *a priori*.

§ 54. Without seeking for additional proofs, we have only to recollect those which have already been adduced in numerous paragraphs; where the total inefficacy of the organic materials, their tendency, &c. independent of the properties of a principle of life, have been stated; and in which also it has been shewn that the sensible materials are laid down by the force of an affinity, which subsists between them and spiritual properties, pre-existent, which have respectively assumed their spheres, and act in them accordingly. From this principle it is to be inferred that the mode of organization is as follows.

§ 55. A combined organic spirit, subsequently to fecundation, begins then to separate its properties; those whose affinity is to form the heart, are not at once perfect relative identities, but become such by many preparatory changes. Changes of the same kind are taking place in the organic spirit destined to form the other parts. Matter is aggregated *according to the states of the principle in its different seats,* each change bringing the constitution nearer and nearer to the condition of fœtal existence. While one set of properties are engaged in the preparatory changes necessary to the formation of the heart, others are occupied in the same way with respect to the blood-vessels. Change succeeds to change; all the properties working with each other, and preserving their true relations in every stage; until, finally, a permanent formation is attained, and the fœtus, hitherto living like a vegetable, deriving the materials of growth by a root, connected with a source of nutrition,

is by the force of its causes made independent of its original, and capable of another stage of life.

§ 56. It will be found that this enumeration of changes agrees with the changes which we *observe*. None of these textures are at once perfected. As the textures are what the properties of the organic spirit make them, so we infer from these mutations of the materials previous mutations of the living principle, and these are the most satisfactory grounds of the inference.

§ 57. The harmony of functions too is preserved in the same way in all the stages of existence; it is preserved by internal relations, which only illustrate a principle of causation, stated at § 38, &c. Chap. iii. Book 1. The relations of the ovum with the mother, during the uterine connections, are next to be considered.

§ 58. The ovum having passed through the Fallopian tube into the uterus, speedily acquires an attachment to this viscus, by which an intercourse is still maintained between the mother and the offspring. It is not necessary, as has been before shewn, that any properties of the organic spirit should be conferred by the mother on the ovum at this stage. This conclusion is principally deduced from the phenomena of the crustaceous ova, which are developed into the future animal without any vascular intercourse with the mother, or, in some instances, without an intercourse of any other kind, between the periods of their escape from the ovaducts and their final maturation.

§ 59. But although it is not necessary that the ovum should acquire the vital properties in the stage we are considering, yet the connection between the ovum and the mother is such that it cannot, during this period, be dissolved without a cessation of the phenomena which characterize the living principle in the ovum. We find, also, that an arrangement, very similar, obtains with respect to the crustaceous ova: thus, if the temperature of an egg is not pretty equally maintained, or if a sufficient degree of heat is withheld during the periods of incubation, the embryo, whatever its present organization might be, dies. The facts, thus indicated, appear to give the sanction of probability to the following inference, which is also supported by other facts to be stated subsequently, viz.

§ 60. As soon as the organic spirit of the ovum has ceased to be a constitution of properties at rest; as soon as the ovum has commenced the actions characteristic of life; that then it is, from the force of its own causes, disposed for death, or a return to its separated constituents. It has been quaintly said that "life is a forced state." I am disposed to say of it, with less quaintness, that it is a constitution disposed to change its form; that its present form is maintained by certain agents, in the usual way of causation; and that its changes also are accomplished according to the same general law. The organic spirit itself tends to change its form, and the textures follow its fate; such is the force of internal causes: the force of some which are *external* is to *preserve the*

condition by which we recognize it as a living principle. At this period of fœtalization, which might be called the uterine period, it is our present business to say what are the agents which maintain the living condition, and the enumeration will not be tedious.

§ 61. It is necessary that the fœtus should obtain from the mother a fluid, which is either blood, or else convertible into blood, by the fœtal system. The office of this blood is inferred in the case of the fœtus in utero, in part, from the known uses of it in the subsequent periods of life; but principally from the consequences, such as the extinction of life, &c. in the fœtus, from an obstructed supply. It is hence believed that blood is the external, which at once maintains the living state of the spirit, and furnishes the materials of the structures.

§ 62. The fœtus in utero is also necessarily exposed to an elevated temperature; whether it is mere heat, imparted from the double source, viz. from the blood, and from the uterine parieties which supports the *living* principle in its preparatory changes; or whether, in the human ovum, this effect is dependent upon certain congenial and adapted properties of blood; is a question upon which we will not assert peremptorily, at any rate until we have recollected some circumstances of analogy.

§ 63. The crustaceous ovum contains the substance which supplies the materials of growth; so far it resembles blood in the other case: this substance is not capable of commencing (although it has the properties of blood) the processes of life, which are begun and maintained by heat.

§ 64. The relations then which we are considering, in respect to the crustaceous ovum, are as follow: 1st, the substance which furnishes the materials of growth can neither begin the actions nor maintain the properties of life; 2nd, heat is capable of beginning and maintaining these processes; 3rd, if, as is proved by many familiar facts, the material, viz. that which performs the office of blood, were withdrawn, then heat could not maintain the processes of life; 4th, neither heat nor blood, the vital principle being extinct, are capable of supporting the processes of life, or of renewing them when they have ceased.

§ 65. It follows, therefore, from the facts in the last paragraph and other preceding ones, 1st, that in the crustaceous ovum a quiescent (quiescent from the state of combination of its properties) organic spirit must exist in the first place; 2nd, that heat makes its properties active; 3rd, that their actions are afterwards preserved, and continued in a series of changes by the conjoined influence, or energy, or causes, of the organic spirit, of heat, and of the properties allied with the material of growth.

§ 66. In the uterine ovum of viviparous animals, we have more difficulty in discovering what share heat has in its growth, because there is not, as in the oviparous animals, a state of rest in the constituents of the ovum for any length of time subsequent to fecundation. But we judge, from the indispensability of heat

(though differently obtained) in the after-periods of life to the continuance of vital processes, and from the extinction of life by a degree of cold which the internal calorific powers are inadequate to resist, that the influence of heat is truly essential to these processes: and if this is a genuine relation between heat and the agent of life, we appear justified in assigning such relation during all the stages of the uterine ovum.

§ 67. In addition to what we observe of the actual relation of heat with life in the maturer periods of human existence, we have the evidence of analogy tending to the same point, derived from the crustaceous ova, whose processes of life, as above stated, are fonnd not to commence without the influence of a certain degree of heat; and if this analogy is true, to the extent upon which it might apparently be presumed, the following view, in regard to the human ovum, will appear to receive its sanction.

§ 68. The fecundated human ovum differs from the crustaceous ovum in the identical properties which compose it, and in the following circumstances: 1st, the crustaceons ovum contains its material of growth within itself, while the human ovum is dependent for the same upon a maternal source; 2nd, the crustaceous ovum, fecundated and prepared for the changes which produce mature organization, waits for the influence of a cause, giving activity to its properties, which cause is external heat; while the human fecundated ovum does not rest for want of such a cause, but is immediately supplied with it, and its properties are rendered active, and they begin to form the textures. Much more remains to be said, under a distinct title, on the subject of animal heat, and indeed on most of the topics hitherto spoken of; but as much is here said as belongs exclusively to the condition of the ovum.

§ 70. It was remarked that the fluid which the ovnm obtained from the mother, was either blood or convertible into blood by the fœtal system. The fœtus, as is well known, or we might say the placenta, cannot be injected through the uterine vessels. Now, as the injections employed are as subtile as blood itself, it is hence concluded that there is no communication of vessels between the placenta and the uterus: how then (the question is much hackneyed) does the fœtus obtain the materials of growth?

§ 71. There is no continuity of vessels between the uterus and the maternal portion of the placenta; the fœtal portion of which is connected with the uterus only through the medium of the maternal portion. The maternal portion has blood brought into contact with it: from this blood it absorbs some fluid, which passes into the fœtal portion of the placenta, and thence to the fœtus. The circulation of the fœtus is from itself to the placenta, and back again to the fœtus: these things are well known. This provision prevents the ill consequences of excessive repletion, or accumulation of blood, in the fœtus, which would happen if arterial blood passed freely into it by a direct communication

with the vessels of the mother. It hence appears that the acquisition of fluid from the uterus by the placenta must be exceedingly slow, or it would be disproportionate to the growth of the fœtus. It is probable that the fluid is thus obtained from the uterus by the slow and well-adapted process of absorption, either animal or capillary; the latter may perhaps be preferred, by reason that fluid is absorbed before absorbent vessels are found in the ovum.

§ 72. That red blood is not absorbed by the *maternal* portion of the placenta, appears probable from the circumstances, 1st, that injections, which usually pass into all vessels carrying red blood, cannot be made to pass through the maternal portion of the placenta; and, 2nd, that in the crustaceous ovum red blood is formed, as in the chick, unequivocally without any absorption of this fluid from the mother; it is formed from a substance which supplies nourishment to the chick, but which is nothing like red blood. Assuming the probability that blood is formed by the fœtal system in the human ovum, and it being acknowledged that such is the fact in the crustaceous ovum, it remains that we inquire how this conversion is accomplished.

§ 73. That red blood is formed by the fœtus from other fluids, is an assumption which rests partly upon analogy; but if the analogy should not be unexceptionable, the reasonings founded upon it will at least be explanatory of some processes of the crustaceous ova.

§ 74. If an egg which has lost its vital principle, or which was never endowed with the fecundating principle (in effect the same), be exposed to a proper temperature (i. e. such a one as would lead to the development of the chick, in an egg disposed for the living processes), the egg in this condition will no more form blood than it will form the textures or commence the other functions. As it has been shewn that the latter are attributable to the operation of vital properties, so it must also be inferred, by parity of reasoning, that the conversion of substances which differ materially from blood, into blood, is a result of properties which belong to the organic spirit.

§ 75. But we have reason to believe that a fluid may contain all the materials of growth, indeed we have many direct examples of it, without answering to the description of blood. And it may be supposed that nutrition may be performed by such a fluid, imbibed in the one case through the placenta, and in the other from the albumen of the egg; the constituents of which fluid, as those of other things, are infinite; requiring only the means of analysis, of which we are ignorant, to shew them to be so. Then the question seems to be, not how a fluid containing the elements of the structures comes to be possessed by the embryon, but how this fluid is made *red blood?*

§ 76. This has been attributed to the agency of mere atmospherical oxygen, but erroneously, as appears from the following

facts: 1st, in the crustaceous egg there is only a very small space, which is said to contain air: it is to be proved that the air thus contained, is sufficient for the oxygenation of so considerable a quantity of blood as is circulated in the maturer embryon. To affirm this postulatum is *contrary to analogy* (upon which the argument on both sides is founded), for we find in that stage of life in which the necessity of a supply of oxygen is unequivocal that no *stationary or fixed quantity* is sufficient; it must be perpetually renewed, or its effect ceases. That this is done in the chick, remains to be shewn; and it must first be discovered that the egg possesses a source of air capable of compensating a perpetual exhaustion. 2nd, The same, or a still greater difficulty of the same kind, occurs in the human ovum, where a source of oxygen is not found to have been provided. 3rd (and most conclusive), Fluids, furnishing all the elements of blood, as those contained in the egg, as those supposed to transude through the maternal portion of a placenta, or even as those contained in the lacteals of an adult, may be exposed to oxygen, pure or mixed, to all eternity, and will not become red blood. Oxygen therefore in conjunction with nutritious fluids *does not make red blood.*

§ 77. But it is obvious that oxygen is capable of changing the colour of blood; we know that exposure of venous blood to oxygen will make it of a bright red colour, and the *privation* of its *oxygen leaves it of a still darker red.* From which fact the absurdity of imagining oxygen to be the *cause of the colour* in blood is very manifest.

§ 78. Neither can we say that iron is the cause of the colorification of a nutritious fluid, 1st, because there is in the egg no other source of iron than that which is within itself; where, if any, it remains combined with the nutritious fluid, *without forming blood* (as before incubation, &c.); and, 2nd, iron mixed with such nutritious fluid, as chyle, for example, whether sparingly or abundantly, will not make red blood: oxygen also may be added and fifty other fanciful ingredients, but nothing will make the identity of red blood where there is the absence of the efficient properties of the organic spirit, which otherwise, by their relations with the materials, do make red blood. This is too obvious to be further spoken of, though the argument may if required be very much strengthened.

§ 79. Notwithstanding all that has been just said to detract from the agency of oxygen, which some zealous admirers and bad reasoners have, in a fit of enthusiasm or insanity, cried up as nothing less than omnipotent and universal; notwithstanding our restrictions, oxygen is proved, past doubt, to be capable of *altering* the colour of blood, and of furnishing it with properties which are essential to the maintenance of life. It therefore remains that we should trace more closely its relations with fœtal existence.

§ 80. It is inferred, *a priori,* that red blood is made by the properties of the organic spirit, in which chymical agents have no

other share than a mere concurrence which is compelled by the laws of affinity subsisting between those properties and the chymical and material constituents. It is inferred, also, that blood being made, oxygen is capable of altering its colour. Dark-coloured blood in the chick is conveyed by the umbilical arteries to the membranes covered by the shell, and it is returned florid blood by the umbilical veins; the same thing takes place in the human fœtus, with this difference, viz. that the dark-coloured blood is conveyed by the umbilical arteries to a thick placentary mass, from whence it is returned by the veins of a bright vermilion colour, &c. This effect upon the blood, this change, is perpetual. It has been remarked (at § 76), that in the case of the egg there is no source which admits an adequate oxygenation by atmospherical air. To imagine that air passes at all through the shell is a mere imagination; and to suppose that it passes through the shell so freely as the argument requires that it should, is too absurd to demand a refutation. The want of a source of air in the human placenta has also been remarked in the same place. We find then that oxygen is not only incapable of converting nutritious fluids into red blood, but even that the colour characteristic of venous blood may be changed to that characteristic of arterial blood, without any thing like an *atmospherical oxygenation*.

§ 81. If the blood of the fœtus does not undergo this change, which has been attributed to oxygen, the fœtus dies. But there is no atmospherical oxygen, or only an inadequate quantity, at the place where this change is accomplished: by what then is this change, viz. the conversion of venous into arterial blood, accomplished?

§ 82. The placenta is a production of the ovum, it is governed by its life, are all other growths and structures; its life extinct, its fabric falls to decay; its chymical properties, also, are dependent upon its organic spirit. It has properties of life, but no others for which it is not indebted to life. Its properties of life are related with those of the embryon, its function is connected with all the parts of the organic spirit of the fœtus; but its relation is not direct but mediate, and not through the medium of the textures, but through that of the blood.

§ 83. The relations of properties of the spirits in different seats, the effects, &c. of their reciprocal agency, how complicated the concurrence is, &c. have been sufficiently spoken of. This is an instance of that concurrence. The vital properties of the embryon are not capable of themselves of maintaining life, or of developing the structures; they want the influence of allied properties: these properties are in the placenta, which are not the identical properties of life, but are made such by their relation with those of the embryon.

§ 84. These properties of the placenta influence those of the embryon by the change they produce in the blood: this change is indicated by an alteration in its colour. The influence which the

blood thus receives perfects the organic spirit, or an essential part of it, residing in some organ of the fœtus, further related with its diffused spirit. As oxygen, as is proved, is capable of producing a similar change in the blood, it is to be considered whether these properties, originally conferred in the same manner as the other properties of the ovum, are identical with oxygen.

§ 85. Oxygen, unassisted by any vital properties resident in the textures, is capable of producing the change of colour mentioned, but whether it furnishes by itself the properties essential to life, or whether the blood is fitted for this purpose by properties of oxygen, conjoined with those resident in the textures, is a point upon which we have no direct testimony; because, when life is extinct in the lungs it is extinct elsewhere, and therefore its relation with mere oxygen cannot be ascertained.

§ 86. But that oxygen is the identical influence which is conferred on the blood in the placenta appears probable. The evidence in its favour is that atmospherical oxygen will produce that change in blood which fits it for the purpose of remote vitality. The truth of this conclusion is to be known only by ascertaining whether the properties productive of change of colour in the blood, and those endowing it with a cause of vitality, belong wholly to oxygen. The affirmative is indicated, and only indicated, by the known importance of oxygen in respiration: and as there is not even an indication to the contrary, we may presume that the portion of the ovum which forms the placenta contains oxygen in alliance with other properties of life.

§ 87. This view of the matter being thus far granted, another, before exhibited, will with propriety be opposed to it. Supposing oxygen to have been originally in alliance with that part or sphere of the organic spirit destined to form the placenta, the quantity of this oxygen must be exceedingly small, not sufficient for one round of circulation, in the latter stages of fœtal existence; and as it is confessed that there is no source of oxygen by atmospherical communication, in what manner is the oxygen obtained which is said to be possessed by the placenta, or how is this small quantity of oxygen (supposing such original quantity to exist) so greatly increased? This objection is well urged, and the explanation will extend a little our inquiries into these mysterious processes.

§ 88. It is obviously necessary that the increase of oxygen should be in a ratio to the increase of blood. As the source of this oxygen is not from without, it must be internal. The only internal source of oxygen is that which is also the only source of the organic materials, the fluids obtained from the matter.

§ 89. To imagine that venous fœtal blood in the placenta becomes oxygenated by mixture of fluids derived from the mother would be to suppose, 1st, a readier communication between the fœtus and the uterus than we have reason to believe; and, 2nd, a rapidity of nutrition (or repletion) would thus be occasioned which does not correspond with the ratio of visible growth.

§ 90. It appears then that there must reside a property in the placenta capable of forming oxygen, by an affinity before-mentioned; a property whose relation with venous blood is to produce an union of its carbon with some other constituents of blood, thus yielding eliminated oxygen to the blood, and accomplishing an end which is otherwise brought about by atmospherical communication. This view supposes an antagonist relation between oxygen (derived from, and in proportion to, the maternal nutrient fluid) with the vital properties of the fœtal system, and oxygen with the vital properties of the placenta.

§ 91. In order to satisfy ourselves of the agreement of this solution with the few facts of which we are instructed upon this subject, it is necessary that we should take a view of these facts, so far as they are connected with the question. The fluid imbibed from the mother contains an immense number of constituents which are capable of appearing and acting distinctly, and of being arranged, and of co-existing when subjected to the influence of a *materia vitæ*, or, as we say, an organic spirit resident in the fœtus. Before this fluid is subjected to such an influence it appears homogeneous, or at least separable by art into very few constituents (the albumen of an egg, for instance, which in the chick furnishes bones, muscles, arteries, cartilages, nerves, brain, feathers, &c.). This fluid left to itself speedily shews its own tendencies, which may perhaps be called chymical: it soon evaporates or putrifies, and disappears. If the changes which take place in it, in order to accomplish the effects just enumerated, may be called chymical changes (which will hereafter be considered), then it is the influence of the principle of life which determines these changes or functions to take place. It is this which changes the relations between the parts of the fluid; it is this, as before explained, possessing different properties in various parts, which acts variously upon the fluid, decomposing and uniting the secret causes of our apparently homogeneous fluid, and alternating these operations, *in infinitum*. The properties of life are thus related with the parts of the fluid, and these effects are accomplished conformably with the relations in the way of causation before described. The placenta, it appears, must be a source of oxygen; it can be a source in no other way than that mentioned at § 90.

§ 92. It will next be inquired how the properties thus related with the venous blood in the placenta come to have so extensive an agency as that which they exert in the maturer periods of fœtal existence, when they prepare oxygen for so large a quantity of blood, seeing too how small a sphere they occupied in the original ovum? In answer to this question, it must be seen what is said hereafter under the title of continuance of life, &c. which also exhibits *processes of growth*.

§ 93. The concurrence necessary to the formation of the textures is, 1st, spiritual properties of the maternal ovum; 2nd, properties of the fecundating principle (these two obey the relations expressed at § 16); 3rd, heat; 4th, a nutritious fluid.

§ 94. The processes of life having been commenced by fecundation, this entire concurrence is necessary to their support.

§ 95. The fecundated ovum, without heat, remains inactive, a mere pre-disposition to embryonic existence; its combined spirit is not developed, and its properties do not assume their spheres, but by the aid of progressive nutrition.

§ 96. The spirit, as is proved by the subsequent organization, the general resemblance to its originals, is perfect in its possession of constituents in its first condition. It depends for the maintainance of its identities &c. upon heat, and the material of growth.

§ 97. The tendency of the spirit, when its properties have begun to be active, is again to return to its state of rest; its activity is maintained by the perpetual supply of its properties, which expire, or change their form if deprived of the source of *assimilation.*

§ 98. The changes of the combinations of the properties of the spirit are numerous: they are strikingly preparatory up to the period of fœtal maturation, and less conspicuously so throughout the stages of after-life.

§ 99. As the combinations are changed, or as the properties of the spirit are altered in their respective spheres, so the effects imputable to them are modified. The peculiarities of combination give rise to the distinction of active and latent properties.

§ 100. The materials of nutrition furnish common constituents: the properties of the spirit render them peculiar; by them they are appropriated, and made conformable with final purposes.

§ 101. The material of nutrition possesses all the properties of every kind, and of every stage, of organic spirits. The spirit of the fecundated ovum assimilates from this material, and the visible constituents with which it is allied are separated from an apparently homogeneous fluid, and are aggregated in the several seats.

§ 102. The textures are according to the spiritual properties of the fecundated ovum, with the aid of the concurrence before-mentioned, which latter is according to the spiritual properties first conferred on the radicles, viz. on the maternal ovum and the seminal fluid. It is by this law that the resemblance of every kind is perpetuated in the succession. Thus all the varieties of oviparous animals are preserved by their eggs, though the vital processes are maintained in them by a common cause, viz. heat; thus, also, all the species of viviparous animals are perpetuated with a minute resemblance to their originals, though they should all feed on roots or flesh, or both.

§ 103. According to the changes of the active properties of the spirit, the visible materials of the embryon are laid down: this is done by a natural and common affinity, without any sort of mystery in the business. The textures are conformable with the spiritual properties; the former exist where the latter are, the former are changed as the latter are modified.

§ 104. From the views which have hitherto been exhibited, it appears that the government of all the embryonic processes is assignable to the spiritual properties of the ovum; that these pro-

perties are those which are conferred by a function of the generative organs in the two sexes; that in the fecundated ovum the properties of the two sexes, which have a general resemblance to their originals, are mixed. The question then arises, by what mode of causation do parts and properties perfectly resemble those either of the father or of the mother, exclusively; when parts and propensities, the first subservient to a similar function, and the second operating with an opposite tendency, are proper to both? Thus, if the maternal ovum is a resemblance in pre-disposition to the mother, it must have, according to our notions, similar sexual organs. The same is to be said of the cause of fecundation. Thus, also, the father's hair may be black and the mother's white; and the offspring, though possessing the radicles of both these peculiarites, shall perhaps manifest only one of them, and that unmodified; shall be either perfect male or perfect female; or shall have hair either black or white, and not of a mixed colour.

§ 105. This apparent difficulty is to be solved only by the relations of properties expressed at § 15; a complicated process of causation takes place between the spirit of the maternal ovum and that of the cause of fecundation; some properties unite and modify each other, and their modification is subsequently denoted by a corresponding state of the textures; others (the third class at § 15) preserve unchanged their own natures. If we ask how these things are settled? it must be replied, we only define a relation subsisting between existences, and we may reduce this example to the level of common examples, and say that the relation here is determined in the same way as that by which an acid and an alkali will unite and form a neutral salt, or as oil and water will not unite; existence forcing existence, &c. But to consider more particularly our present example.

§ 106. It is first to be shewn that the principle, viz. the possession by the seminal radicles (*cæteris paribus*) of all the properties of the originals is not invalidated by the facts, which is indicated with some force by the following circumstances: 1st, A woman, the offspring of one of an hemorrhagic idiosyncracy, shall attain old age without the slightest apparent tendency to hemorrhage, while in her children, or in some of them, and not in others, the hemorrhagic idiosyncracy shall be so prevailing that profuse bleedings will occur on the slightest occasions, and sometimes without any assignable cause. The next generation of those who bleed shall manifest no such disposition, while the children of those who did not bleed shall preserve the strength of the tendency in the originals, and even transmit it with many irregularities to posterity. 2nd, The same is to be said of scrophula, of consumption, and of most or all hereditary diseases. 3rd, The same is to be said of the colour of the hair, the development of the textures, the formation or absence of fat, the peculiarities of features, of the peculiarities of the moral character, of the peculiar strength of certain persons, of insanity, &c. In all instances spiritual properties are conferred on the

offspring by progenitors, which properties are variously active or latent according to relations which are so far beyond the scope of our experience, that it looks almost like temerity to hazard another conjecture on the subject. We will not however absolutely leave off here: conjecture is a sort of pioneer, whose business it is to force a road of *some kind:* if the track can afterwards be followed with advantage, so much the better; and if it cannot, why even then conjecture, the pioneer, only takes a pleasant walk by himself in a shady avenue of his own making.

§ 107. It is to be inquired, what is the causation in this particular instance? It is to be asked, 1st, why hermaphrodites are not produced by generative processes? 2nd, what becomes of the superfluous sexual pre-disposition in the offspring? 3rd, what are the causes prevailing *sub coitû,* if any? We will repeat these questions in their order, and answer them so far as our evidences will permit.

1st. Hermaphrodites are not produced by generative processes, because the relation of the sexual pre-dispositions is not to unite and modify each other, but to preserve their own identities. 2nd, What becomes of the superfluous sexual pre-disposition we cannot say, but the alternatives are, that it is in alliance with the active sexual pre-disposition, or with the organic spirit in some other sphere; the former appears not improbable, and is consistent with a similar predicament of two causes, capable of exerting themselves in the whole system, and producing each its peculiar effects. Thus a child may one day be exposed to the contagion of measles, two days afterwards to that of small pox; the causes of those two diseases will exist in the body at the same time, and it is most probable that they hold the same seats, yet the child may first have the small pox, and, though not subsequently exposed to the contagion of measles, may afterwards have this latter disease when the former have run its course: this I have witnessed, and there are a hundred similar facts. Now, in explanation of this circumstance, it will be said the poisons were inconsistent with each other, and therefore could not run their course together. This however is only another mode of stating the fact, it is no explanation; to discover the explanation, we must ascertain the relation of the other properties of the organic spirit with these causes respectively. However, such as the explanation is, transfer it to the sexual organs, and it will appear in this form: the sexual radicles in the uterine fœtus are inconsistent, and cannot both have sway together; neither can one modify the other; what happens then? Why, either sexual pre-disposition is not like the contagion of fever, it is not evanescent, nor does it terminate in mere actions; its tendency is to live permanently, by assimilation, and the force of its influence is to govern the textures which are conformable with its prevalence. In this way the maternal ovum may furnish the male organs; in *what way?* it will be asked. Thus: the female possesses the inactive sexual pre-dis-disposition of the male; and this, in her a latent cause, might be an active one in the ovum, which is formed by derivations from her

organic properties, and *vice versa.* We have experience of this relation; we know that these sexual differences are both possessed where one only acts. Now the next question is, what determines one to act or to be latent, in preference to the other? 3rd. This is a point which others have in effect conjectured upon; it has been attributed to imagination, operating *sub coitû,* as whether the idea of man or woman was most prevalent, in a kind of contest which took place between them. It has also been said that there are pre-formed male and female ova, and the development of either determined the sex; and there are the conjectures of some microscopic observers, which are reducible to the latter class.

The former of these conjectures, viz. the prevalence of an intellectual imago, or any other cause prevailing, *strictly sub coitû,* is superfluous and inconsistent with analogy, for the sexual differences take place in offsprings produced without coitus, by mere impregnation of female ova, deposited in sand, or in the beds of waters, as among fishes; besides which, the sexual differences are preserved in animals which have no imaginations (at least we find no poets among them). The first fact, while it sufficiently refutes the first conjecture, appears to indicate the truth of the second, viz. that maternal ova are of two kinds, male and female; that whichever of these are impregnated, such is the sex.

But this conjecture involves the suppositions, 1st, that the whole business of determining the sex rests with the female; and, 2nd, that the original can confer that of which itself has no prototype or resemblance. Without stating the objections to these suppositions, and without shewing how irreconcilable the first is with a whole class of facts, and among others with those expressed at § 104; we will make shorter work of it by refuting at once the conjecture itself, which is this, that the organic spirit of the organs of generation is furnished by the female universally, and that the male furnishes no spiritual properties of this kind. Now the refutation of this conjecture, and the establishment of its converse, which has been all along supposed, also upon different grounds, are found in this fact, that the generative organs, like all other parts, are modified by differences existing in both parents: thus the generative organs of the products of a variety of the species are modified in their development, as in the mule, &c. and do not resemble those where the species is unmixed, as in the horse or the ass. And the colour of the skin too is found to participate here in the general deviation from that of either parent, as in the mulatto, with many other facts of the same kind.

Thus we see that notwithstanding the inconsistency of the sway of both the sexual pre-dispositions, there are yet, even here, some properties which do unite and modify each other, while others act with an unchanged identity, and others remain latent, preserving also, in a state of rest, their own nature.

To return to the question, if we would know by what laws this relation is governed, or what the variety of cause is which deter-

mines these different effects, we must first obtain some additional inlets of experience, by which we may get acquainted with the properties in question, and by which we may be enabled to distinguish their modifications from their regularities; we must even go further or we shall yet be but imperfectly taught, we must have a perception of the tendencies, or a familiarity in the history of the causation of the regular and the occasional. And until we have obtained these additional inlets of experience we must be contended to define relations in a more limited way, in conformity, as has been done in the present case, with the largest class of facts and the most general indications.

I conclude this chapter on the fecundated ovum with observing that many of the processes which are discussed in it belong also to the subsequent conditions of life, and that therefore the more ample consideration of some points already touched upon will be reserved to a future part of the subject, when the illustration will be less abstruse, because the facts are more familiar.

CHAP. III.—*The Origin of Man by Constitution.*

§ 1. WE have seen that the existence of man is *perpetuated* by derivation. This appears too to be the general mode in which the whole animal creation is *perpetuated*. We cannot however affirm that this origin, by derivation, is *universal*. The prevailing form, the general rudiment of future being, appears to be furnished by ova, evolved from the females of the respective species; but that this form of origin is not universal, appears from the examples of constitutions, which are admitted to belong to the animal creation, among which, our experience does not inform us of the existence of ova.

§ 2. The microscopic observers have detected animals of this kind in vinegar and other fluids, in a mixture of flour and water, &c. In these instances it is by no means ascertained that animal existence is produced from a parental rudiment; on the contrary, it appears to be produced by a change, the obvious part of which is of a chymical kind, as one of fermentation. Myriads of animals appear to start into being in the short space of a few hours, without being preceded by those formal processes which constitute the terms of the existence of man, and of the general tribes of animals. It has been suggested that the fluids in these cases may obtain the ova of the animals they contain from the atmosphere. Such a supposition is contrary to analogy, for the known ova of animals are specifically heavier than atmospherical air; and if they should, in compliance with an unsupported supposition, be allowed in these instances to be lighter than air, very little is gained by the postulatum; for if they are so much lighter as to rise out of the element in which their progenitors must have deposited them, the same cause should certainly secure them against the possibility of *gravitating* into the same situation again.

§ 3. These examples of apparently spontaneous life, as well as some principles before sketched, suggest to us a consideration of the origin of man which is more remote than that by derivation, which is, unfortunately, prior to any possible records of experience, and on which we are therefore but indifferently prepared to inquire with success. However, we will hazard a few thoughts even on this doubtful topic, which, it must be premised, makes no part, or but an unimportant one, of the general design of this work.

§ 4. All mankind, it is said, have had one common origin in first parents: by which is meant that from two individuals existing as the only examples of the species, ova were furnished by derivation, which produced others of the same kind; to these last succeeded another generation, to this another, proceeding on to such a multiplication of individuals as may be said now to constitute the whole of the human race; and the same is said of other animals. Mere unassisted reason, working with the materials which are supplied by observation of the order of nature, her capacities, &c. if compelled to say something upon the subject, would propose two modes of the multiplication of the species, viz. either by an origin in two common parents, or by a derivation from numerous parental stocks: the latter mode pre-supposing that the causes which formed man and woman in one place might have formed them in many others, perhaps about the same time. As we profess here to pay some respect to this same unaided reason, however little it might be entitled to it, it is necessary that we should take these alternatives into consideration.

§ 5. We perceive, upon the first view, that a peremptory decision is in this case quite impossible, and that to conjecture with any sort of probability is, to say the least of it, very difficult. It is proper to inquire, in the first place, how far history can assist us in the determination?

§ 6. It appears that history has but a very weak voice, when the business to be spoken of is one so remote as that we are considering; because, at the first periods of human testimony, written or traditional, the earth was found to be *already peopled in many places*, and though one tribe might so far simplify its ancestry as to reduce it to an origin in one father and one mother, yet it could not be ascertained that people existing elsewhere owed their birth to the same originals; there may be even no testimony that these first parents were at all related with a *neighbouring tribe*, much less with the inhabitants of distant nations.

§ 7. But the proof of the origin of the human species in two first parents has never been rested upon human record, because it is obvious that none of such antiquity can exist; and even if it did exist, the question would occur whether such record did not apply to one tribe or to one nation, rather than to those others which are scattered over the earth. But such a proof has been grounded upon a revealed account, which assigns one origin of mankind, &c. in first parents, viz. in Adam and Eve, who were *created* (furnishing an illustration of the origin by constitution) and another origin (by derivation) in the family of Noah. The descendants of the first were destroyed by a deluge, those of the second exist now, and have been multiplying ever since the subsidence of the waters.

§ 8. This account is not traditional, or preserved in manuscript, but rests upon the credit of an inspired writer. This authority will be respected on the one hand by those who acquiesce in the full scope of inspiration, as it is represented to us; or, on the other, it

will be rejected by those who are not disposed to yield to the doctrines of inspiration an assent equally implicit, or who may perhaps regard inspiration as the assertion of probable conjectures.

§ 9. But as this doctrine of inspiration stands, as it were, contra-distinguished to mere rational deduction; as it is adopted upon faith principally, though perhaps supported in some measure by collateral testimonies of another kind; it is obvious that our inquiry, which professes to be an examination of the results of unaided reason, must proceed upon other grounds: we therefore take leave of the authority of inspiration here, leaving it to be received upon the terms on which it is proposed, viz. upon faith.

§ 10. That the whole of the existing human race had their origin in two first parents, cannot become a matter of inference, from any ancient testimonies or recorded facts; because such reports must necessarily be partial: they may relate to one or two nations, but not to all the places upon the globe.

§ 11. Neither can the *universality of a deluge* be proved by such ancient testimonies, for precisely the same reason, viz. that if only one family should survive a great inundation, this family can afterwards testify no more than that it alone, of all the people of a district or a country, escaped such an inundation; and that this family began anew to people the land upon which it was left by the retiring of the waters. This family, without the aid of inspiration, being necessarily precluded a knowledge of the inhabitants or occurrences, belonging to a distant soil, is, from this limited information, qualified to speak only of its own. Thus, if our own island should by a sudden subsidence become covered by the sea, to the destruction of all its inhabitants, save one; that one, if he transmitted the account to posterity, would affirm that the deluge was *universal,* provided he was unacquainted with any country beyond his own; and if he should have been acquainted with some neighbouring countries, as Scotland, Ireland, France, Holland, &c. and if these should have participated in the general wreck, he would still be unqualified to give an universal record, since the inhabitants of America, and of the East-Indies, during this great European inundation, might be quietly cultivating the soil, or following their habitual pursuits, without the slightest knowledge of this formidable catastrophe. In fewer words, no man can attest the fate of a country which he does not know to exist; and the earliest inhabitants of the globe are not likely to be acquainted with any other country than their own, because a facility of intercourse, or even a *possible intercourse,* between distant countries is a result of the arts, and belongs to a later period of civilization. We are therefore to seek for other proofs (of the natural kind) of an origin of the human race in two first parents.

§ 12. It will be said, by way of furnishing these proofs, that every part of the earth, so far as it is known, bears traces of a deluge, in the formation of rocks, in the stratafication of materials, in alluvial soils, &c. Now if it be granted that the things just

quoted are proofs indubitable of the operation of waters, who shall say whether these several effects, which we allow to exist every where, occurred *every where* at the *same time*, or by partial and successive acts, or changes, which have been wrought in an infinity of ages? It is obvious that, up to this point, proofs are entirely wanting; and though I am aware that a great deal has been said with something like a design of fixing the antiquity of the earth, and that a great deal more might, in the way of discussion, be said on both sides upon the same subject; yet all that has been said, or may be said, is so entirely conjectural and contradictory, that I chuse to say nothing more about it. Let us endeavour to find some better security for our proceedings; a sanction which shall be founded on some part of our own experience.

§ 13. As, by the order of procreation, the species is multiplied, so by inverting this order it is diminished; and by continuing to trace succession from children to parents, it appears that we should at last arrive at such a simplification as that which is denominated one common origin in first parents. Thus much we may affirm, so far as respects our general experience in population; but we are not to concede the universality of such a result without a little further examination.

§ 14. The animal creation exist on so large a scale, that it is difficult to illustrate the question clearly, by a reference to the aggregate of species. We will then make an imaginary reduction of their numbers, and suppose the condition of mankind, for example, to be this, viz. there are one hundred inhabitants in each of the quarters of the earth. We will suppose these, as we may, without affecting the argument, to be divided into families consisting of ten in each, viz. two parents and eight children; it is then obvious that eighty drew their origin from twenty. If we inquire the origin of these twenty? the answer will involve alternatives which we should not at first sight suspect. 1st, These twenty might have derived their existence from forty parents, viz. a father and mother to each one, and these forty from eighty; or, 2nd, they might have originated from four parents, and these four from two, &c. So that we cannot, by the inverse succession of the general tendency of procreation, arrive necessarily at that simplification which it appears at first sight to promise, for the rate of population is liable to fluctuate from many causes. To state this matter more plainly:

§ 15. It is possible, from a gradual decline of population, that a thousand inhabitants of any part of the earth may, by many fluctuations, be reduced to a hundred; that this number might be doubled, and then reduced to fifty, to four; or the race might become extinct. Hence, if any people should have preserved a record of two or four or twenty ancestors furnishing the originals of ten tribes, it does not absolutely follow that these first were instances of the origin by formation or constitution, or but that many generations might have preceded those who are regarded as originals.

§ 16. Now that such a reduction of the numbers of a people as from a thousand to a hundred, or even to the extinction of the race, should happen, does not seem in any degree probable, according to our own experience of the tendency of population, which, without specifying proportions which cannot be ascertained, we know to be generally towards a rapid increase. But the state of things, the causes which prevail in our days, may not have prevailed in ages past. This, it will be said, is urging a mere possibility without data; but the supposition is not so absurd as to some it might appear.

1st, We know that the business of population requires the possession of certain faculties allied with the procreative organs.

2nd, These organs, like all others, are liable to spontaneous disease, by which a function might be impaired, while even the structure is preserved.

3rd, We know that many (perhaps we may affirm of the predisposition, the great bulk) of the diseases to which our organs are liable, are hereditary. In this way, or from these causes, the tendency of population would be to the extinction of the race.

4th, Independently of spontaneous disease or disorder, to which the organs in question, in common with the rest, are liable, they are exposed to the influence of moral habits, which may be of such a nature and so prevalent at particular periods of the world, as to frustrate that design which nature never appears to have lost sight of, viz. the perpetuation of the species.* It is unnecessary to cite examples here; we may advert, as to a class, to the ineffectual commerce between the dissolute of either sex. A period of the world, the moral condition of which would render prevalent the relations just cited, would tend to a reduction of its inhabitants; and a period of the world in which such a relation was universal, would lead to their entire extinction.

5th, And that the conjecture of these possibilities is not without the support of actual experience, appears to be indicated by the facts that there have been found the remains of men, of a size which has given rise to the inference that the existing inhabitants of the earth are no descendants of their's, but belong to another ancestry, and that their race, there being no living remains of it, has become extinct. The same has been observed of other animals, as of the Mamoth, and many strange things exhibited in museums, bearing the traces of animal remains, but of which we have no known examples in the living state. But all the causes above-mentioned cannot well apply to these latter instances; that is, they must be exempt from the influence of moral depravity, but they are not exempt from the influence of physical change.

§ 17. We find in some districts a peculiar conformation of the thyroid gland, associated with the other phenomena of cretinism.

* It is said that population in New South-Wales is now (1816) on the decline, owing to the abuse of European habits.

We find in others a prevailing tendency to calculous disorders: now the same mode of causation as may render prevalent a depravity of function or conformation in one structure, may produce a similar change in another. We have even the record of a negro whose skin has spontaneonsly become white. Here the descendants of such a one would most probably be modified in a particular which has been a *characteristic* of their progenitors. The histories of epidemics both in men and brutes tend to the same evidence. In a race which is not numerous, whether of men or animals, we are supported by our present experience in the supposition that a prevalent depravity of function in the generative organs might arise, and that, being continued, under many of the modifications which would result from sexual intercourse, it might by many approximations eventually lead to the extinction of the race. But this mode of explaining a circumstance, which has excited little more than the curiosity and astonishment of naturalists, is rather foreign to my present purpose; it is sufficient for this to shew, as has been done, that the rate and order of population among the human species is liable to be retrograde or progressive, according to the operation or absence of the causes enumerated; and that therefore, and for the reasons which precede this enumeration, and for many other reasons, if they are required, an origin of man by constitution *can never be authenticated by any records which a people might have preserved of the first founders of their race;* and it seems the less worth while to bestow more words upon this point, as no such *records* are even said to exist, which affirm an absolute beginning in two first parents.

§ 18. If then neither record nor tradition can furnish us with examples of the origin of man by constitution, it remains to inquire whether by the laws of constitution itself we are led to such an inference? Viewed upon this ground, the question resolves itself into the two following alternatives: 1st, has man existed for ever or from eternity? or, 2nd, has there been a period when he began to exist?

1. It has been before said that nothing can exist without a cause: how far this principle is to be admitted may be seen at § 8, 9, 10, &c. Book I. Chap. ii.; at § 2, Book I. Chap. iii. where the grounds of it are stated. Now if nothing can exist without a cause, it follows that the existence of every thing began at some period, for the time of its causation was that at which it began to exist. It will be inquired if this conclusion applies to forms where there is a provision for endless perpetuity? it will be inquired whether the principle proves a first origin of the human species? These questions relate to an apparent distinction between those parts of nature whose similitudes are propagated by derivation, and those which being once formed are liable only to re-combination or analysis, and which have no succession of resemblances.

§ 19. It seems scarcely necessary to examine in detail these questions, which are excepted against the principle: for it appears to follow, demonstratively, that if there is no possible example of existence which is not dependent for such existence upon a process of causation, there can be no example of an existence which has not at some period begun to be. But, if the topic should be resolutely pursued, the substance of the investigation would be thus comprised. Although we have seen that the phenomena of nature are in many acts which are visible, and in many more which are inferred, accomplished by a process of causation, which fixes the era of their being; is it not possible that there may be some *eternal monuments,* which have preserved through numberless ages the characters by which they are now recognized?

§ 20. To suppose that any such monument existed would involve the following objections, the last of which is not easily obviated: 1st, it would leave its *existence* unaccounted for; and, 2nd, it would imply an existence according to some other mode than by a combination of its constituents. Thus, the peculiar instance in question is shewn to rest upon the same grounds as those general ones which have been before spoken of: and the truth of the general principle referred to in the chapter on Causation will give precisely its own credit alike to general instances and to every particular application. Upon this authority, then, the proof of the origin of man by constitution is rested; but whether this origin took place only once and in one place, from which single act of primitive causation the present aggregate of the species have proceeded, or whether the same constituent powers have been at various times and in varions places exerted, giving rise to many primo-genitors, it has been seen that neither record nor physical testimony, so far as we have examined it, has been adequate to determine.

§ 21. In a matter so intricate, it is no mean acquisition with respect to a general design, to have come thus near to a settlement of one leading point: and having by the help of our notions on causation advanced one step, it remains for us, availing ourselves if we can of the same help, to consider what other conditions are implied by this origin of man by constitution. It is once more to be premised that our present occupation consists in making an experiment, the design of which is to ascertain how far, and to what results, mere unaided reason is disposed to carry us.

§ 22. Here again our choice of the mode of the first formation of man seems to lie between the two following alternatives: 1st, whether he was at once formed and perfected in this state; or, 2nd, whether he arrived at it by numerous changes, which would furnish the materials of a long history of approximations?

1. That the entire man* was at once formed by a congregation

* Man is taken here merely as a specimen of the animal creation, the other parts of which are to a considerable extent governed by the same laws.

of his materials, is a supposition little better than absurd; our experience of his growth from the state of the ovum refutes such a notion, for we observe that his internal functions must subserve to his formation and development in every stage. Thus we have dismissed the first alternative very briefly, our business now is with the second.

2. Recurring to our doctrines of the ovum, we have seen that the formation of an organic spirit must precede that of the textures. As this has been shewn to be a necessary relation, equal to that of cause and effect, it is obvious that our examination of the mode of a natural origin of man must begin at this point.

§ 23. We find, variously scattered in the immense extent of being, a principle which has in many respects a resemblance to the organic spirit of man. We find it throughout the animal and vegetable creation, fulfilling (modified indeed in the several forms) a similar function, that is, it governs their textures, and prevents their decomposition. In tracing the sources of this principle we shall find it to exist in substances which are not organic: we perceive that the earth contains it; that from the state in which it exists in the earth it is convertible into that in which it exists in plants and animals; and that, finally, by a few transmutations it assumes another place, and constitutes the living principle of man.

§ 24. This principle is not only or wholly derived from the earth: it floats in the wind, the air breathes life, the waters yield their vital principle, all abound with the spirit of animation, and furnish it to myriads of tribes; some of these, again yielding, others adopting it: by a few simple changes it is identified with each, and something like a common principle may be discovered in all its modifications. We cannot call this principle *universal:* but we cannot limit its extent; it is widely prevailing, its alliances are without end, and it will be considered more closely when we speak of its particular relations.

§ 25. We stand in need of no other facts than those just mentioned to shew the liability of this principle to a change of form, or rather to a modification of properties. These facts, also, independent of our general doctrines of causation, shew it to be no *simple principle*, but an example of being, which, like all others, is made by its constituents. We infer too from the same facts how endless are the relations of the principle with earth, air, water, and even fire, with organic forms, with its own constituents, these decomposable, part related with some substances, and again its remaining properties with others; finally, throughout nature it has its alliances; and its connections and its possibilities are infinite. It is governed by its constituents, it is modified by these relations and these alliances; it furnishes integral parts of their being, or it receives from them permanent or evanescent qualities, which, by force of all prevailing affinity, are detached from, or endure with, their original receptacles. This series is endless: identities preserved, or changes wrought, all governed by causes,

fixing, and in turn obeying relations. Who shall limit the execution of such grand alliances? who shall say what cannot result? Let us however descend to the more humble employment of tracing faintly what might result, or what has been done.

§ 26. Beginning then with almost perceptible effects, *that spirit of man* whose influence has been before partially developed, we find, is identified. It is identified by what? Our doctrines tell us, by its causes; these working, through all that complexity of relation above sketched, imperfectly. Thus much in a general way: but is not the manner to be traced more closely? Let us examine what those processes of causation might be to which such rare phenomena have been ascribed.

§ 27. Of the particular causation of the organic spirit of man it is impossible to speak with precision in the limited state of our experience; many questions must arise to which no answers of the *satisfactory kind* can be given. These questions may serve to exercise the ingenuity of those who chuse to exercise their ingenuity upon them; and if they would attain an absoluse success, they must first discover some new laws and principles to work with. Some of these questions are the following: 1st, *Where* was the organic spirit of man first constituted? 2nd, By what *previous acts* of causation were its elements associated? 3rd, At *what period* were they combined? 4th, Was this spirit identified *at once*, or was it a nucleus, which received many accessions until its perfection was accomplished? 5th, What are the elements, or what are the causes, on a gross analysis, which compose it? &c.

§ 28. Then, considering it in its union with the material organs, it is to be asked, 1st, What was the primitive state of the spirit in regard to them? 2nd, What were the circumstances necessary to its forming the corporeal alliances which it has now attained? 3rd, Was the present formation of the textures at once produced, or by many preparatory changes? These and many more questions must arise upon this intricacy: our unaided reason shall shew to what extent she dares proceed towards their settlement respectively.

1. It is totally beyond the scope of the wildest conjecture, founded on any thing like natural evidence, to say *where* the organic spirit was first produced, there being no more reason for preferring one place than another. Nor is it possible to say whether it was formed by constitution in *one place*, or in many, seeing that we have no grounds for supposing that the agents by which such a process was accomplished, existed in one place and not in another.

2. In order to determine by what previous acts of causation the elements of this spirit were associated, it will be necessary, first, to ascertain the agents engaged in the work, and, second, what the relations of these agents were with each other, together with a history of the influences and mutations which they had themselves suffered. It is obvious that nature has never been

examined with this view. The most that has been done is to have remarked some few effects which belong to the origin by derivation, and to have theorized a little upon these topics; we have no experience to help us in this decision, not having known an origin of the human organic spirit but by derivation. Facts also, which would afford the evidence even of a weak analogy, seem to be wanting, because such a drift of inquiry has never been indicated, without which previous step it is scarcely to be expected that in a matter so remote and intricate any data should be attained. As it is now less my business to discover new facts than to reason upon those which we have, so for the present these questions must be dismissed.

3. It is equally impossible to pronounce at *what period* these elements were combined, since traditional evidence has been found defective, and since too, in the immensity of duration without beginning which has belonged to the world, the same changes might have recurred many times; it might have been peopled by the causes which have made our generation what it is; destruction might have succeeded, partial or total, in regard to human forms, and myriads of ages might have elapsed before the materials of the universe were disposed to repeat their former processes of causation.

4. Whether or not this spirit was formed at once or by many approximations, we are equally unqualified to pronounce upon, by reason of the absence of direct proofs. It appears that it would be supposing a concurrence too complicated for one single act: on the other hand, it appears that if the state of life is not directly established, that combination which belongs to it would tend rather to decomposition than to a gradual perfection of its nature. This consideration, however, belongs not to evidence of the decisive kind.

5. Lastly, that we are ignorant of the elements of this organic spirit will not be doubted. It is true we have a satisfactory information by inference of many things which its properties are capable of accomplishing; we may acquire no despicable instruction on its laws; but to say what these properties are, that is, to discover that they resemble precisely, or are a part of, any thing of which we have experience, is beyond our warrant, because its properties have no perceptive relation with our senses. Not to extend any further an examination which must be futile, we will merely say that the obstacles to a decisive apprehension of the mode of the origin of the spirit by constitution will interfere generally, to prevent our understanding of the modes of its alliances, &c. with the grosser materials. We have therefore done with a fruitless search after evidence of the first or second order upon these points, and will next proceed to indicate the force and tendency of evidence of another description.

§ 29. The elements of life being furnished from their proper sources, our choice of these sources must be directed by our

nearest experience. Now we find that the earth and the air are commonly related in the causation of life. We find in them the materials of life, and of every species and form of life. These then, from which life is perpetuated, we may most reasonably conclude to be the sources which originally furnished life.

§ 30. Whether the life of man was at once formed from this intercourse of earth and air, we would not attempt to determine when, before submitting to conjecture, we were looking about for proofs. But now, having confessed a weakness in the argument, we may venture to string up a few reasonings. We find then that the different specimens of life are to a great extent, if not altogether, preparatory. Thus, in the sources which we have named it exists in no specific form. But it is disposed for spontaneous changes, by which some of the most simple forms are produced or have an origin by constitution; among these we have some instances in vegetation, as in the growths of mosses, mucor, fungi, some aquatic weeds, &c. which originate, as is believed, without seeds. The form of life in these examples is one modification of that informal state in which it exists in its sources. *As every change of form is a change of relation* by which the way is prepared to another change of form, so the first spontaneous formal condition of life, which arises out of its elements in earth and air, is a pre-disposition to another. What that other will be depends upon existing relations, upon the state of causes. The possibility of the materials of life existing informally in its sources, assuming a defined form, will not be denied because we ourselves have experience of the fact.

§ 31. One form of life having arisen from its sources, what is its next fate? Perhaps it sheds seeds and is thus perpetuated, or else it dies; and what then? Simply this, that its life is preserved in death, that its death is only another condition of its life. How is this proved? it will be asked. The proof I shall give at length in another place, suffice at present to say that it is proved in two ways: first, that every change happens by causation, which implies addition or diminution of properties, so that life in death is *modified* only, and in one of these ways; and, second, that those materials with which an organic life once inhered are found to furnish an organic life to others of the same or of a different species. Thus much being granted (and all its evidence shewn, we may be bold to say it cannot be denied), this point being granted then, we find that this first form of life is changed in death, and has relations which in that state, which for distinction we call life, it had not. In death it exists, and is operated on by the causes related with it; and it requires no more than the same kind of concurrence among causes as that which first made it a specimen of formal life, again to become life in a second form.

§ 32. But how, it will be asked (supposing that this explanation of a spiritual origin may be admitted), how does this form of a principle possess itself of a corresponding material form? This question has been already answered, or nearly so, in speaking of the relations between the spirit and the structures, in our doctrines of the

ovum. We will however repeat here (referring to these doctrines for the grounds of the assumption), that this spirit has a relation which has been called one of affinity with the materials; that its place (determined by previous acts of causation), being where these materials are subjected to the spiritual affinity, they are aggregated or arranged according to its agency.

§ 33. Thus then we perceive that an apparent distinction or subdivision arises in the modes of origin by constitution, viz. one which is primitive, resulting from relations between the elements of informal life, contained in its sources; and another which is secondary, or arising from a former condition of life, which has been modified by death, and is consequently prepared for further modification by a *necessary change in its relations.*

§ 34. Now although this distinction appears to be not weakly sanctioned, yet in the real nature of the processes there is no difference; both these modes of origin being resolvable into those universal ones of causation, viz. by addition or subtraction of properties. In this way that which is called informal has been shewn to become formal life; and in the same manner one spiritual form is by death rendered different from the last; and when again it appears inhabiting a material fabric, it then is that which it is made by a repetition of these same processes; modes of causation, common both to the primitive and secondary forms of life. The distinction may however be admitted, principally for verbal conveniences, having defined with what limitations it is to be received. Thus much may be said of spiritual origins in a general way: let us return however to that particular one whose history we have more especially undertaken to trace.

§ 35. We have discovered the complexity of the human organic spirit by considering its properties in their effects upon the structures, &c. From this complexity we are inclined to infer that such a spiritual condition is not at once attained. It appears contrary to the little experience we have in the origins of some of the meanest and most simple forms of life, to imagine that by any single change in the relations of informal life such a state of the principle could at once result.

§ 36. If then this argument (which is of the presumptive kind), supported as it is by all the experience we have on the point, which is little enough, should be allowed to deserve consideration, we should conclude that many forms of organic life preceded the integrity of a human spirit. We should, in conformity with such a view, conceive that its first production from the sources of its elements constituted the simplest state of formal life; that this state of life gradually became more complicated, 1st, by its modification in death, and, 2nd, by a subsequent change of relations and properties which caused it again to be exhibited as a specimen of formal life.

§ 37. By a repetition of such processes it is impossible to limit the forms of life which may thus be produced. The near relations

subsisting between the different forms, the facility of their conversions from one state to another, we have before been reminded of, and shall hereafter more fully apprehend, when our business is to speak of the *maintenance of life* and the *manner of assimilation.*

§ 38. Thus then we have faintly sketched, we may perhaps say, the probable modes of spiritual formation. There are involved in the sketch many objections of a minor sort, which I have not thought proper to notice; and, on the other hand, many collateral circumstances of equal force may be adduced in support of these views. Among the objections which might be urged I shall notice only this one, viz. if man was once formed in this spontaneous way, merely by a train of causation (wrought, it must be remembered, in an infinity of ages) and by a concurrence of elements, how comes it that we have now no examples of such an origin?

§ 39. To this objection, the force of which is not very great, it may be answered, generally, that all the parts of the universe are in action, undergoing perpetually changes among themselves, changes of combinations resulting from the particular states of causes, fixing particular and present relations; that therefore we are not to expect at this period, or at this stage of change, the same results as occurred perhaps at times incalculably remote. This remark is sanctioned by experience as well as induction. History has preserved many *solitary* facts in almost every department of creation; facts which have occurred at one period of causation, effects for which there has been since no relation prepared, no concurrence to give them birth. But I propose to treat the objection a little more respectfully.

§ 40. Supposing the inference, that the complicated have arisen from the simple forms of life, to be correct; to descend a little more particularly into the subject, the question is, how it happens, seeing that the first and simple forms of life are now produced from their elements, that they do not in time become converted into the complicated forms, thus extending our experience of origin by constitution? This question is replied to in a general way above, and now more particularly as follows: 1st, The state of the elements of life (their relations, &c.) existing in their sources is necessarily very different, before these elements have been disturbed, before they have established the complicated forms, from the condition of them when their processes have been vastly interchanged, and when, finally, all the effects of their causation are accomplished. 2nd, The conversion of the simple into the complicated forms is shewn to be dependent upon the condition of the elements. 3rd, There being now no examples of the spontaneous origin of the complicated forms of life, indicates only, agreeably to the argument, that the series of causation which produced these forms has long since been at an end, and that the aggregate condition of life, being now different from its primordial condition, *is established in other relations,* is governed by another causation, which, among its other results, has prepared the means of identical perpetuity rather than of further change. Consistently with this last observation (which is indeed a

part of our experience), I am disposed to impute very little of the variety of animal forms to the casualties of sexual intercourse and to the peculiarities of nutrition; for, in the first, we find that the offspring of these casualties of intercourse are incapable of perpetuating their kind (this at least holds good generally of the varieties of species), and, with regard to the second, we are assured by experience from the earliest recorded time to the present, that animals and vegetables have preserved characteristic marks of their primitive identity. This is a strong tendency in nature: it is exemplified in the results of grafting, in the varieties of animal and vegetable forms which are preserved respectively under *common* means of nutrition, &c.; at the same time it is not to be expected, as will hereafter be more fully remarked, but that the means of nutrition may to a certain extent modify or influence the form of life, these two constituting a relation. And some strange products may occasionally result from a commerce which may be said to be unnatural between animals; of which products there may now exist some solitary remains: the Mamoth however is not to be reckoned of this number since its remains prove it to have been *larger* than any known animal; whereas if it were a product of the above description, it would be *less* than the largest known animal, partaking in this respect of the difference of properties between the parents. It is to be inferred for this reason (if the specimens are not artificial and the accounts fabulous) that this animal at least belonged to a race which, owing to some of the causes before enumerated, has become extinct.

§ 41. Having once come to a conclusion of an origin of man by constitution, whether called a creation or however denominated, in conformity with our principles of causation, we are compelled to make the following acknowledgment, viz.

That at a remote period of the world the constituents in it from which such an organic spirit as that we are considering would result as an effect, were disposed to unite and produce as a separate combination in nature the spirit in question. The concurrence of constituents at this period was determined by one of two modes of causation, or by both, viz. the constituents previously disguised in another constitution, were suffered to form the identical spirit by an agency which detached them from their former alliances; or by an agency which furnished *additional properties to constituents which were not otherwise identical:* these agree with the only possible modes of causation, by subtraction or by addition of properties, or both.

§ 42. After all, we are, by candour and a just regard to truth, obliged to confess, that the most plausible conjectures on this remote business of the origin of vital forms by constitution are, in their application to particular processes, to be very scrupulously received.

BOOK THIRD.—OF POST-FŒTAL LIFE.

SECTION I.

GENERAL RELATIONS.

CHAP. I.—*Condition of the Spirit, &c.*

§ 1. THE organic spirit is liable to the application of all those laws which have been noticed in the chapter on Causation: the proof of which is that those laws are universal, and the grounds of this last assumption are stated in the chapter just referred to.

§ 2. By these laws of causation we are taught to regard this spirit as no simple elementary principle, but as containing an infinite number of properties by which altogether it is constituted.

§ 3. The spirit itself is not an object of sense, but its existence is inferred from its operation. The effects of its operation are so numerous and the instances so familiar, that the supposition of it acquires a currency and credit in our reasonings equal almost to perceptive knowledge. The existence of this spirit being once inferred from its effects, we next begin to class those effects, giving corresponding denominations to the properties of the spirit by which these effects are accomplished.

§ 4. The progress which has been made in this work of analysis and classification is not much to be boasted of; the most that has been done is to designate three or four species of contractility, from which has originated a vast deal of erroneous and absurd reasoning. The spiritual phenomena have never been considered in their true mode: I shall proceed merely to shew in this place that a proper foundation for reasoning about these processes has not yet been indicated.

§ 5. The phenomena of life, it has been said, are produced by the operation of stimuli on that which has been called "excitability." By the proportions, &c. of these two the state of excitement or of

life is regulated. The varieties of life or excitement are also said to be two, viz. a state which is above and a state which is below a given standard; all this may be very true, and yet we are very little the wiser for it; it is equally true that life is life, that life is either good or bad, and that when life ceases death begins.

§ 6. And with respect to our contractilities: their enumeration is very correct, but they lead to the mistake of considering phenomena in relation only to *quantities and degrees* where an *altered constitution has taken place.*

§ 7. Thus supposing the action of the heart to furnish the criterion of the proper state of health, and that the precise standard of it, estimated by the frequency of its movements, consists within the range of from 60 to 80 beats in a minute. Now the heart might assume an action of the following kind: the first day of change it may beat at the rate of 96 in a minute, the second at the rate of 110, the third at the rate of 100, the fourth at the rate of 90, the fifth at 72, and the sixth at 60. We see these fluctuations, and our experience allows us to be capricious in assigning the order of variation. At another time the action of the heart shall on the first, second, or third day also reach 110; but instead of being reduced by the sixth day to 60, it shall for months fluctuate between 90 and 120, and may even reach 160; and whereas the accession of disease in the first case terminated in recovery in six days, the termination of the second may be at the end of six months in death. In these two cases the *rate* of pulsation, the *degree* of action, was at some times precisely similar. Why, when in the latter, as in the former case the pulsations were at 90, did not the same termination ensue? The answer is very obvious: it is because the heart was affected by *two different diseases,* by which we imply, that the principle which governs the action of the heart had assumed two *different conditions.*

§ 8. We have the same testimony from the actions which we observe in any particular structure, in diseases whether purely local or conjoined with an altered constitutional diathesis. Thus two cases of pneumonia shall be equally violent, one shall have terminated in resolution in twelve or fourteen days, the other in the formation of an abscess; in one the heart shall have regained, in less than a fortnight, its healthy rate of action, in the other this action shall never be restored. Why was pus formed in one case and not in the other? We have just grounds for believing that the rate of pulsation, &c. in the affected vessels was the same; further, vessels will sustain any degree of circulation without forming pus; we must therefore say that some other cause, some other condition of disease operated in one case and not in the other, which governed the termination respectively.

§ 9. Thus, also, in some persons (those of a nervous temperament) the pulse shall be raised at one time to 100 in a minute, while the subject is conscious of the possession of perfect health; at another time in the same subject the pulse shall not exceed 90 or 96,

and shall be accompanied with other characteristics of fever constituting a state of disease.

§ 10. Thus also it may happen to the same person at different periods of his life: at an early period, to sustain an inflammation of the toe or foot which will proceed to suppuration and finally to recovery, embracing in its course the whole range or every degree of action; at a late period of life in the same seat and in the same individual there might occur an inflammation exhibiting a perceptible action or circulation, similar to that which had been formerly experienced; this last diathesis, instead of suppurating, instead of the termination in recovery, may end in mortification, and perhaps death, within 48 hours. Here, as in the other cases, there might be identity of degree (and if such identity is allowed on a comparison at any period respectively of the two cases it is sufficient for the argument), but *difference in the state of the governing principle.* The same might be observed of vitiated secretions; and indeed the same results of comparison might be deduced in every instance of disease, whether the comparison is made between similar conditions in respect to degrees of action, &c. of the same person at different times, or of others. If there is a single instance in which the degree of excitement, which shall be estimated according to any standard that might be proposed, will account for all the phenomena of disease, I will never urge another objection against its sufficiency.

§ 11. If I were disposed to pursue this subject to greater length I should shew the fallacy of some arguments which have been urged in favour of the doctrine alluded to, as well as bestow a notice on some others which might be made in reply to the preceding objections; but this would be to anticipate a part of the subject which will hereafter be distinctly spoken of. I shall here therefore merely remark in addition, that the state which agrees with the precise though arbitrary condition of health, may obtain many times in the course of disease, and yet under the use of ordinary diet or of medicines, with whatever view directed, the constitution shall digress repeatedly into the former state of disease which may terminate either in death or recovery. Thus an intermittent pulse might become regular, and in less than an hour may intermit again; thus a person shall be wholly freed from a collection of water, and under the prevalence of habits which were previously compatible with health shall again become anasarcous. These events depend upon pre-disposition, or a state of the principle, the peculiarities of which can neither be specified nor even conjectured.

§ 12. As much as has been said in regard to a pathology which looks only to the degrees of excitement, &c. (which by the way can never be ascertained by any single criterion) is generally applicable to the doctrines which have been founded on the contractilities before spoken of.

§ 13. Thus we say that such a one is a disease of excessive irritability: we will take for example, as being familiar, an ulcer, the indisposition of which to a healing process is attributed to

excessive irritability. We will suppose it to be ascertained that the property denominated sensible organic contractility, or that which is more immediately connected with the circulation, is alone interested in this disease; the disease is said to consist in an excess of irritability. Thus far we have stated a case which we must next examine.

§ 14. The word " excess" is applicable only to the sum or quantity of that which is excessive. How, I would ask, is it ascertained that the natural irritability is increased in quantity? I may take it for granted, without presuming too much, that we have no measure of the quantity of the principle of irritability. If it be said that the effects of irritability furnish this criterion and this proof; then I reply that it is in order to shew them *to be the effects*, that the criterion and the proofs are wanting. If then we are unable to estimate the quantity of irritability, why introduce it into our reasonings? Why presume to explain phenomena by that which itself stands equally in need of explanation? It may further be urged, there is in the case supposed an excess of intensity or of degree, rather than in the quantity of the principle resident in the seat of the disease. This may be compatibly with the application allowed above to the word excess; of this " degree" we shall have occasion to say a few words hereafter.

§ 15. But, to go further, let us allow that irritability either in quantity or degree can be measured in some way or other, loosely or accurately, no matter which; let us allow this, and then examine whether all those phenomena of the irritable ulcer are referable to the quantity or the degree of the sensible organic contractile power.

1st, The discharge may be sanious and offensive: in what manner does the degree of irritability regulate this particular? The only function which is attributed to this contractility is to govern the action of vessels: what rate of pulsation then, or if this objected to, what modification of caliber is required to produce a sanious discharge? Such a question, involving so much improbability, was perhaps never thought of, it is therefore no wonder that it is not answered. But that the secretion is not produced by any rate of action, by any degree of the principle alone, seems to be proved by the fact that an ordinary specimen of phlegmonous inflammation in some or other of its periods embraces every rate of action, every condition of an inflammatory diathesis; at least, if we cannot discriminate a difference in favour of that connected with our sanious discharge, we have no right to presume it. But suppose even that a difference of action in the vessels were perceptible, suppose also that a suitable caliber of the vessels were assumed (which last is supposing a property superadded to that which merely governs the rate of pulsation), suppose all this and every other convenience, the effect would then be that the fluids contained in the vessels would be circulated or poured out either faster or slower than in an ulcer of a different description. Now we know that simple pulsating tubes of a certain area, a mere hydraulic process, can never give a product of secretion;

for every variety therefore in the quality of the secretion we must infer a corresponding condition of the nature or constitution of the cause upon which it depends.

2nd, With regard to the disposition of our ulcer in other respects, instead of healing it becomes more extensive; these differences are not dependent merely upon a power whose only property is to make tubes contract faster or slower, to render them larger or smaller, to make them pour out their contents or not pour out their contents. The disposition of the ulcer must be regulated by causes capable of producing more than the effects of hydraulic agency, seeing that its disposition is expressed by processes and varieties in which hydraulic agency can take but a subordinate part.

3rd, The condition of the ulcer gradually changes, and new organic substance is produced from it. What *degree* of a principle capable of exerting only the single property of regulating the action or caliber of vessels is capable of forming an animal structure? of endowing that which it has formed with life? of rendering it capable of more phenomena than can be enumerated? I shall pursue this topic no further at present: I will merely remark that these proofs are also applicable against the sufficiency of the other contractilities. Without therefore continuing my objections to the doctrines of life and disease which have prevailed, and do prevail, I shall proceed to state what appears to me the true mode of considering these subjects, the latter of which, viz. disease, being here cited only in the way of illustration, will hereafter be distinctly spoken of.

§ 16. It has been shewn, in treating of the conditions of the ovum, that the organic spirit is vastly compounded; that it has many properties has been there demonstrated by tracing their particular acts, and that its properties are infinite is shewn by the general principles of causation.

§ 17. Hence its general condition is this: it is one whole, the parts of which (to render the division comprehensible) exist in several spheres, which agree with the portions, whether large or minute, of the organized fabric.

§ 18. This spirit shews itself to be possessed of a great diversity of properties in the different material systems; it has in every seat numerous relations: by these relations it is either preserved identically, or modified and by them its identity or its modifications are expressed.

§ 19. The effects of the combinations of the properties constituting the spirit may, to a certain extent, be said to agree with the contractilities before referred to. But it must be remembered that these are only certain effects of properties which are latent and which have an internal causation, and alliances both regular and occasional by which phenomena are produced and diversified. Whether a better classification of these effects may be adopted will be considered hereafter.

CHAP. II.—*Of the Mode in which Life is maintained.*

§ 1. IN a case of *death,* while the blood is yet fluid, life is not to be *renewed* by any means: we may inflate the lungs, or restore the temperature, or stimulate, as it is called, the internal organs, as the stomach and bowels; we may electrify or galvanize the body; but we shall not *re-produce* the phenomena of the living state: or, lest some objection should be conceived to this example on the supposition of an injury of the textures or a change of the fluids,

§ 2. We may amputate a limb, and inject or transfuse blood, which is fit for nutrition, blood which is impregnated with air, arterial blood into its vessels; but the phenomena of life will not ensue.

§ 3. It is proved by these facts (and indeed by many others which, with the inference, are sufficiently familiar) *that life is not to be conferred by the only externals which support it,* viz. by food, the appropriate parts of which are contained in blood, and by air, of which in its animal relations blood also appears to be the medium.

§ 4. But we find, that in cases of asphyxia, where life is not extinct, the means above mentioned will succeed in restoring its phenomena; and, what is still more unequivocal and pertinent to our present purpose, we find that the means above mentioned do support life, and that the defect of either is followed by death.

§ 5. Hence it appears that life is supported by the conjoined influence of air and food; and that neither, singly, can support it. It is also to be inferred from these facts, that life itself operates upon air and food to the end of its own perpetuation.

§ 6. This last inference is further proved by the fact that those elements in air and food, which to the living principle furnish life, have no natural affinity; that is, they are not found to unite and produce the phenomena of the living principle spontaneously, however effectual their mutual exposure might be, but are always *ready to yield the principle when subjected to its own influence.* But as these materials, viz. those derived from earth and air, are found to possess the elements, it is not, as hinted in the article on the Origin of Man by Constitution, an extravagant conjecture to imagine that an accidental union of the elements might, under peculiar circumstances, take place, though contrary to our experience of their regular tendencies.

§ 7. As we see that life would become extinct but for the support and renovation of its elements, and as we see that these elements require the presence of life, in order that they also might become life; we must infer that the influence of life, in regard to the substances which contain its elements, is to unite these elements, by which they in turn become life, *and an uniting principle in regard to other materials.*

§ 8. It is proved by the necessity of the frequent renewal, or rather the constant supply of its materials, that a given quantity of life is no sooner formed than it passes away; that is, this portion dies, or changes its form and relations: what becomes of it will be considered hereafter.

§ 9. Hence it follows, that the duration of life is not dependent upon the *sum of the principle,* whether conferred on the ovum or collected in the stages of growth, for then it would not stand in need of the support of external causes.

§ 10. Nor is it to be imagined that life is maintained by a process of constitution of the following kind, viz. that a principle which is a mere pre-disposition to life is originally conferred, which is permanent, and the portions of which are made life by the combination with an influence from the externals, air and food. This is not to be imagined: 1st, because there is an entire want of evidence for the truth of such a conjecture; 2nd, if a durable quantity of such a principle were conferred, an animal that died from privation of the mere auxiliaries of this principle, viz. from the privation of air and food (or blood), should be revived by a restoration of these only concurrent means, which a permanent principle of pre-disposition wanted only to become life. But we find, on the contrary, that to preserve life, requires the presence of no single property of life, but of the living state; and this living state ceases altogether upon the privation of the means before-mentioned. Such a doctrine as expressed in the above conjecture is by these facts irrefragably confuted; and by them it is proved with equal force and clearness, that the following is the true process of the maintenance of life.

§ 11. *The principle of life, or, as we have hitherto expressed it, the organic spirit, exists in every part of the textures. Blood, containing the elements of life, which are furnished by its two sources before named, viz. air and food, is every where diffused among the textures. The exposure of that which contains the elements of life, to life itself, is in this way complete. The next operation is simply this: that life, by an affinity subsisting between itself and its elements, separates them from a common material, and* unites *them.*

§ 12. In this manner the life contained in the blood, in the condition of latent properties, *becomes by a common act of causation the form of life, resembling that which produces it.* As every quantum of the principle is produced, it operates upon the elements (or unites them) for its renewal and it vanishes, successive quantities *in this way* perpetuating the existence of the living spirit.

§ 13. If proofs should be required of the truth of this account, I say they are already given; but if a repetition should be demanded for the purpose of a stricter comparison with the doctrine, they are as follow:

1st, The condition of the support of life is an adequate supply of the two externals.

2nd, Life immediately ceases when either is withheld.

3rd, The two externals are incapable of maintaining life, *unless life is present.*

4th, *Life is maintained by this threefold relation.*

As the identity of life would cease but for the influence of these externals, so its identity being preserved by their influence, the operation of life on them is not to produce any thing foreign, but to *assimilate its identity;* and as the externals before mentioned are the sources from which life is assimilated, and as in them it exists *informally,* that is, in the state of its elements or constituents, so the *process of assimilation is to unite the elements by which an identity of life is preserved.*

§ 14. This reasoning admits of being placed in many other points of view; but to me, by the *combination* of the facts, the inference is so clearly demonstrated that any additional illustration seems superfluous. The blood is no animal, nor vegetable neither, but it is the material containing the elements of life: *it is a further preparation of the informal life which exists in earth and air.*

§ 15. In conformity with our general principles of causation, life has been before said to contain an infinity of properties: it is not here necessary to give so much latitude, we will merely say that it is identified by many properties. These properties correspond in their variety, to say the least of it, with the varieties of the whole animal and vegetable creations; different properties of life are not merely exhibited in the different classes of animals, but also in those of the same species. Hence the various forms of bodies, hence the several configurations of organs subserving to the same purposes, hence all the varieties of size and growth, hence the varieties of pre-dispositions, with many other hences.

§ 16. The general law with respect to the generation of life, appears to be that every specimen of it assimilates from the common elements its own precise identity; this is determined by an affinity or relation which is settled by the causes involved in life itself, in a way before explained. Thus, every animal and every tree maintains in perpetuity its own characteristics: and thus every body preserves for the future a conformity or resemblance with the past; all obeying the common relation of cause and effect: existence forcing existence.

§ 17. But although this law may in the gross with correctness be said to be general, yet it is liable to many interruptions, still however in obedience to the universal laws. The preservation of a species is interrupted by various accidents before enumerated, and the perpetuation of the past identity of an individual is inter-

rupted, 1st, by the development of latent causes, which are internal, and, 2nd, by varieties in the nature and operation of externals.

§ 18. Both these distinctions are highly important, but the first is more particularly so, from its application to many processes otherwise obscured in mystery. It is by this law that the organic changes take place which are conspicuous in the several stages of life; and by it the order of disease is for the most part regulated.

§ 19. In treating of the ovum we have found that the differentials, whether active or pre-disponent, which serve to distinguish one specimen of organic existence from another, are possessed in the ovum by derivation, and are not attributable to the influence of externals. The proofs of this are variously scattered in the article alluded to; I shall not therefore refer precisely to them, but merely recapitulate the two following: 1st, that with oviparous animals all the fœtal processes by which the animal is identified are conducted without any *external material of nutrition;* and, 2nd, that with all viviparous animals (as well as among vegetables) the characteristics of the respective species are preserved, and even tendencies expressed which are peculiar to the parental stock, under the influence of externals which are common to them all. These proofs may also be strengthened by recurring to our principle of causation; but as the subject is already separately spoken of, such a recapitulation seems superfluous.

§ 20. Every property of life which acts requires to be renewed, and for its maintenance must therefore require, and find, a similitude in the material of nutrition.

§ 21. But as life appears in every sphere to possess an integrity by which no property has an independent fate; that is, when the whole exists the whole assimilates; and when the whole has ceased to be a whole no single properties are indicated to remain; and more especially as we observe that when the latent causes from parental pre-disposition become active, they also are renewed from a source: on these accounts it is probable that the whole life, such as it is constituted by its sum of properties, passes away and is renewed by assimilation: and if this is the case it follows that its latent or passive properties are supported, as well as the active ones, by this same process of assimilation. The argument derives additional credit from the following considerations, namely,

§ 22. That properties of pre-disposition conferred on the ovum, and which for years have remained latent, do when they are become active find their similitudes in the common material of nutrition, and are perpetuated by assimilation: such is the case at the period of puberty, when a peculiar secretion is produced by the agency of life from glands which never secreted before; and the faculty of this secretion, obeying all the other laws to which life is subjected, acts and is renewed with considerable duration.

§ 23. Hence the terms of the continuance of a pre-disposing property with the general constitution of the principle of life,

must depend upon its tendency to assimilate, under all its circumstances, and this latter will be fixed by its relations with the other properties of the spirit. Enough is here indicated of this relation: it remains to be pursued under the title of disease.

§ 24. But this spiritual assimilation does not comprehend the entire relation between life, and the medium or material of its elements. At the same time, as life is maintained in every seat in the way described, it separates from the material of its own elements also the materials of the textures. The manner in which this is accomplished has before been said to be by affinity; but this is a word expressing only the name of the relation. If it were possible to make a more minute analysis of the relation we should be furnished with some very important knowledge of the agents engaged in the relation, and might still reserve the term affinity, to designate the modes of indivisible processes. Let us attempt something in the way of illustrating such an analysis.

§ 25. As every organic particle composing the structures is first formed, and its cohesion with the rest afterwards maintained, by the organic spirit, so every organic particle is a seat of the spiritual properties.

§ 26. As the blood (which will be shewn more particularly hereafter), or the fluids separated from it, is the material of nutrition, so one condition of the agency between life and the fluids is that the latter should permeate the organic particles. Thus the material is exposed to the agency of life, the results of which are,

1st, That life produces itself from the material in the way described.

2nd, That it produces the organic particles, determining their arrangement, &c. as before proved; and,

3rd, That, having produced the structures, it preserves their coherence: our present business is with the two last.

§ 27. 1st, The alternatives with regard to the formation of the structures are, 1st, whether they are necessarily attached to the formation of life itself; or, 2nd, whether their formation is the result of a distinct agency of the spirit upon the material.

§ 28. 1st, That the aggregation of the particles of the textures is attached to the formation of the spirit, requires to be further explained. The proposition supposes that the elements of life in the material are allied with those grosser parts which become the organic particles; that various forms or combinations of the properties of life (as has been shewn) are contained in the same material; that every form of life existing in a texture assimilates its own form; and that as the properties constituting this form are separated from the blood, the peculiar material particles with which they inhered in the blood are separated also, thus at once perpetuating the living principle and aggregating the structures.

§ 29. Now this theory seems to agree very well with that unity of operation which we perceive in every other animal process, of which we have a tolerably clear understanding; but it is irrecon-

cilable with the following facts: 1st, the process of spiritual assimilation is unremitting: and if, with every new portion of the spiritual elements, an accession of new organic particles were also to take place, these having a permanent place, the increase of the structures may proceed *ad infinitum.* 2nd, As the spiritual assimilation goes on under all circumstances of disease, &c. as long as life lasts; so there would, according to this notion, be no possibility of a waste of the structures, unless the *quantum* of life were diminished, for the spiritual and organic formations must proceed together, they being inseparable; a result which is contrary to facts, as is exemplified in fevers, atrophy, &c. 3rd, The basis of the theory stands in need of support equally with the theory itself: for, in the first place, it requires to be proved on its behalf that the elements of the spirit are united with any order of particles, independently of some intermediate bond, as by chymical or other properties; in the second, it requires to be shewn, supposing that the spiritual properties are thus allied with material particles, that this alliance is not divorced by the process of the spiritual assimilation; and in the third, it must be shewn likewise that these material particles, and no others, existing in the blood, are those which are found in the respective structures. This theory, therefore, from the force of the facts just mentioned, I cannot help rejecting; though if it had been allowable to have passed off a theory as a true explanation, merely because a beautiful harmony would have been exhibited by it, the one in question might have been extended to many other points, and raised with an agreeable construction.

§ 30. The second alternative is whether the formation of the structures results from a distinct agency of the spirit upon the material? The conclusion of the affirmative is established by a combination of the proofs before cited, which shew the indispensability of the spirit to the formation of the structures, and those other proofs just mentioned, which are meant to refute the alternative above discussed. But to recapitulate some of these proofs: if life (as has been shewn) operates to the formation of the structures, then the structures must be formed by it, either during its own assimilation in the way described, or as a subsequent act of life. As the state of the textures conforms not with the *assimilation* of life, which is *perpetual,* but with the *dispositions* of it, natural or diseased, so it must be inferred that the textures are affected and governed by the *constitution* of the spirit.

§ 31. Thus, then, life existing in the several seats forms the structures which constitute those seats. This process requires not an elementary condition of life, but the living state of it; we cannot therefore say whether all the constituent properties concur to this end, or whether the organic particles of the material are related in such a way with only some of them. From our ignorance of the constituent properties, our analysis of the operations of life are likely to be very deficient: for we are compelled, on

almost all occasions, to designate the influence of spiritual properties by the term "life," which includes them all; we should therefore describe, as nearly as we can conjecture, the process of organization in the following way.

§ 32. The organic spirit in its several spheres has a relation with its own elements in the blood by which it lives; and another with the organic particles existing in the same fluid, by which they are separated from the blood, and deposited in places agreeing with the continuous spheres of the spiritual properties, by which they were decomposed from their alliances in the state of blood. The particles, thus formed by life, afterwards become inhabited by life, as is proved by their resisting the tendency to putrefaction, which otherwise belongs to them. This leads to the other result, which has been left for consideration, viz.

§ 33. 2. That life, having formed, continues to preserve the structures. In order to preserve that which the spirit has produced, it is necessary that the spirit should reside in the organic particles; it then maintains their coherence by a continued operation of *that same affinity which was before competent to dissolve former connections and assign them a separate place.* The mode therefore in which the strnctures are preserved during life, is one which is simple and in strict harmony with the preceding acts.

§ 34. But this union between life and the organic particles is not permanently maintained during the living state; for the old particles are perpetually passing as excrementitious into the circulation. When, therefore, life ceases to preserve the place of a particle which it has once assigned, it must arise from a change which the particle has undergone, or else from another complex relation, or antagonist process of the spirit, by which the former relation between it and the organic particle is made to cease: then life, in this minute sphere, being free or unengaged, if such is its disposition (as it commonly is, except under disease), produces a new particle, by which the old one is in effect replaced, the continuous spheres of the spirit compelling a corresponding continuity of the particles composing the organized fabric. These latter particulars will be hereafter more fully considered.

§ 35. Thus much for the present of the mode in which life is maintained. Many other considerations belong to the same subject: but these, together with, I fear, some other unavoidable repetitions, will fall under more particular heads.

CHAP. III.—*Growth.*

§ 1. AS it is a property which belongs to the spirit in the several minute spheres, to withdraw from the material the organic particles which agree with these spheres; so, *cæteris paribus*, the quantity of organic matter thus withdrawn must depend upon the quantity of the spirit, or of those properties of the spirit by which the organic particles are separated.

§ 2. But the assimilation of the spirit may proceed while the organic substances are wasting. This disposition therefore to aggregate the textures is no necessary condition of the existence of the spirit, unless we suppose that under these circumstances the quantum of the spirit itself is first diminished; a supposition which cannot, without further evidence, be indulged, because it is contrary to what happens in spiritual assimilation, where the original quantity tends to increase, as is exemplified by recovery in cases of asphyxia, in limbs which are almost dead from privation of blood, as by a ligature around an arterial trunk, and the vitality of which is rapidly restored in all their parts as soon as the circulation is established by the collateral channels.

§ 3. The aggregation of the organic particles will depend, as before shewn, upon the disposition of the spirit; and will proceed, not in a ratio to the quantum of a living principle, but in a ratio to the quantum of the spirit disposed for such a relation with the material.

§ 4. This spiritual disposition cannot operate alone, but requires also the presence of organic particles in the material; by the relation subsisting between these two growth is regulated.

§ 5. A deficiency of growth can seldom arise from a deficiency of organic particles in the material, except under disease; if the sum of the ingesta might be taken as a criterion of the sum of organic particles in the blood, for people of the greatest bulk often eat the least.

§ 6. But this criterion is not unexceptionable, for the aptitude of organic particles for aggregation will depend upon the offices of the preparatory organs. But we are, nevertheless, not without some testimony in favour of this point, and it is found in the fact that the blood will continue to support the fabric for a considera-

ble time without the renovation of ingesta, with no greater diminution of bulk than that which may result from frequent or continued excretion. But the waste which succeeds to a long privation of food, or an habitual scantiness of it, shews that the facts alluded to will not sanction a very general or positive conclusion.

§ 7. We may therefore designate the relation we are considering more correctly, by extending a little the chain of dependences. Thus, the process of growth depends, 1st, on the disposition and quantum of the diffused spirit; and, 2nd, upon the presence of organic particles in the material: both these depend, in different ways, upon preparatory functions, to be spoken of hereafter: but when the effects of the relation take place, they prove the agreement of the agents, the tendencies of which we are further to consider.

§ 8. It is sufficient for our present purpose to insist upon the balance hinted at in the last paragraph, for there are no circumstances of health or disease which will enable us to decide peremptorily when defective nutrition is attributable to the state of the spirit, or when to deficiency of organic particles in the material; thus, leanness might succeed to disorder of the abdominal viscera, or to continued fever of the low kind, while the usual quantity of food is taken: shall we say that under this state the defective nutrition arises in consequence of a disorder of the stomach, &c. which impedes its function of preparing organic particles for aggregation? We can scarcely affirm this, in the first case, because the state of the diffused spirit is liable at all times, directly or indirectly, to participate in its apparently local changes; and in the second case, the same is to be observed of the state of the preparatory organs in respect to a febrile diathesis. Owing therefore to this reciprocation, we must be content to reason upon the facts we have, rather than assume those which we desire.

§ 9. We are then justified in assigning only thus much as a basis of this relation, namely, that growth or increase requires the concurrence of an adequate quantum both of the disposed spirit and of the organic particles; and that decrease, or the reverse of growth, might result from defect of either.*

§ 10. The processes of growth are continued from the existence of the fecundated ovum to the period of adult age. Growth, especially in the uterine stage, is not a mere increase of bulk; but many new parts are formed and many conversions occur in those already produced. The examples of the former are found in the formation of organs and structures, of which in the ovum no similitude could be detected; and the composition of which could neither be discovered in the primitive radicle, nor in the nutritious fluid which assists its development; the examples of the latter are found by a comparison of the adult fabric with the state of

* I am sufficiently aware of a function of the absorbents which relates to the same end; but this will be subsequently spoken of.

organization in the different stages of fœtal growth, as jelly with cartilage, cartilage with bone, membrane with bone, &c. These conversions have been already considered, and they have been attributed to a progressive causation in the spirit, by which the properties which compose it are variously wrought into action at different times.

§ 11. But the accumulation of *similar substances*, or increase, is our present topic. Now as this process is preceded by an increase both of the particles in the material, and of the aggregating properties of the spirit, it is necessary that we should inquire how these take place.

§ 12. In order to produce an excess of organic particles, it is required that the blood should contain more than are necessary to supply the *waste* of organic particles, which is supposed to be unremitting, the terms of which will be spoken of hereafter; and on the part of the spirit, it requires that the blood should contain more of its elements than are sufficient to maintain its present sum: the terms of this also will be spoken of under the functions of the preparatory organs. But something more is required on the part of the spirit. By what law of assimilation is the sum of the spirit regulated?

§ 13. This question suggests the following deduction, viz. that the tendency of the spirit, at least during the periods of growth, is to unite a greater sum of its elements in the material than its own original sum.

§ 14. The manner in which this is done is as follows: a fluid, containing the elements, passes in the way of circulation the several minute spheres of the spirit; as much of the elements as is submitted to the operation of life, by its agency becomes life. Thus, if the quantum of the organic spirit in the material is greater than that which is necessary to support the quantum of that which actually lives, then the latter will be increased.

§ 15. But this point is one the difficulties of which can be explained only by recurring to our preliminary doctrines on causation. First, to state the difficulty: the argument supposes the living spirit to be a lesser sum of its identity than that with which it is related in the elementary state; in what way is the lesser capable of affecting (as in this instance it must do) the *whole of the greater quantity?*

§ 16. This is a question which has been already answered generally, when considering the laws of proportion. To apply these laws to this particular instance: the relation of the living spirit is with its own sum of the elements, and the process arising out of the relation is of that kind which has been before designated "simple increase by affinity." The living spirit is related with its own sum of that in the elementary state; the operation of the former on the latter is to separate it from its elementary combinations: thus the same identity being augmented, is capable of extending the influence which is peculiar to it; and in this way the elements submitted to its agency cease to be the elementary and become the living spirit.

§ 17. But it has been already shewn that the spirit changes its form nearly in a ratio to its elimination from the elementary combinations. The manner in which this tendency affects the process of assimilation is as follows: the spirit endures a sufficient time to produce, in the way described, a repetition of itself, or, if the elements furnish a larger quantity, to increase itself; in other words, the *union* of the spiritual elements is more rapid than the extinction, or the change of form, which happens to the living principle. The proofs of this tendency are, 1st, that the sum of the living spirit is increased during growth in the several spheres; 2nd, that if its endurance were not sufficient for such an operation on the elements, the sum would not only be not augmented, but it would not even be preserved, for extinction then would be synchronous with production. Having settled thus much with respect to the growth of the spirit, we must now return to the increase of the structures.

§ 18. One proof of the dependence of the aggregation of the solid particles upon the living principle may be here recapitulated, viz. that this living state having ceased, the textures (and the particles composing them) left to the force of their own constitution, which is both mechanical and chymical, tend, not to aggregation, nor even to the preservation of their present state, but to separate from each other and return to another alliance with elementary combinations.

§ 19. Thus, then, the living principle has in this respect a double operation upon a material containing many constituents: one is to renew, and increase perhaps, itself; and the other, to renew or increase the solid particles which are conjoined with it in the agency of function. The following conclusions are in consonance with these views.

1. The quantum of the spirit depends upon the quantum of the elements exposed to it, which are contained in the blood.

2. The quantum of the elements depends upon the preparatory functions.

3. The disposition of the spirit, in regard to the structures, is regulated by latent causes which belong to it.

4. The quantum of the textures depends, 1st, upon the quantum of the disposed spirit, and, 2nd, upon the quantum of the organic particles in the material.

5. The quantum of the organic particles in the material, depends also upon the function of the preparatory organs.

§ 20. It is almost superfluous to make the application of this reasoning: to save, however, the reader the trouble of doing it for himself, it is as follows: both in embryonic and post-fœtal growth the identity of the spirit (or its properties in the several spheres) determines its affinity with the organic particles; the particles laid down in the several seats are according to this affinity; and the mutations of the properties constituting the affinity, are followed by corresponding changes of the structures. These mutations are illustrated in every stage of fœtal growth; and afterwards in all

diseases followed by change of structure. As growth is progressive from the state of the ovum to adult age, so, during the whole of this period, the concurrence of disposition and quantum of the spirit, of spiritual elements, and of organic particles, operates. The ratio of growth is settled by this concurrence, or by the agents severally or collectively engaged in it. The *varieties* of growth are dependent upon the modification of this concurrence, the share of the absorbent function being included in that which has been designated the "disposition of the spirit," considered in its integrity in regard to the organic particles.

§ 21. Life, producing the structures by its affinity, &c. holds the same affinity as long as it is preserved; and life, inhering in those materials which it has aggregated, would without some further process of causation maintain the coherence of the identical particles which it had once laid down. We are now conducted to a more particular consideration of the force of the *absorbent function.*

§ 22. The question first to be settled is, whether any such waste, any such perpetual absorption, as that which has been current among physiologists, actually takes place? The admitted proofs of the absorption of the solids are as follow: 1st, the osseous particles being dyed with a colouring matter received in the way of food by an animal will be found, it is said, to have been removed in a certain time after this peculiar food has been discontinued; 2nd, the bulk of the solids is reduced by fever, and the pressure of morbid growths upon the bones will make them disappear. The first has been considered as furnishing the strongest proof of this perpetual absorption of the impacted solid particles; let us therefore examine it.

§ 23. As the osseous particles are made red by madder, and as this *redness* afterwards disappears, it has been inferred that the osseous particles are also removed, in order to account for the disappearance of the redness. This, it must be confessed, is very close reasoning. However, close as it is, it does not appear quite impossible but that the bony particles might remain when the colouring matter has disappeared; for wherever the colouring matter can be deposited, there the fluids which are its medium must penetrate. As long as the animal is fed with madder, the bones will continue to be tinged by it: but when this feeding is discontinued, then the dye is very naturally washed off by the fluids which are constantly permeating the places where they before reached, in order to impart the colouring matter. There is no great difficulty supposed in this process.

§ 24. But in less than a week after this peculiar feeding is left off the osseous particles will have assumed their natural colour: hence it follows, if the cessation of the colour is produced by the removal of the bony particles, that all the osseous matter existing in the body, at any given time is removed in a few days. Now as the bones are not better supplied with absorbents, or certainly more liable to absorption, than other parts; it follows, further, that not only all the bones, but the whole mass of solids, are removed and

renewed in the course of a few days: and all this latter process from no other imputed source than what a man eats and drinks, which is not a little wonderful, considering that it is not the custom for men to eat their own weight of food in five or six days, to say nothing about those considerable portions of it which are known to be excrementitious.

§ 25. With regard to the second proof, viz. that bones, &c. will disappear under disease, this might be accomplished without any vessels distinct from those which are continuous with the arterial system; for by disease the life of a bone, &c. may be destroyed to a certain extent, and its particles, being comminuted and their union dissolved, may be received into and propagated along vessels whose extremities are patent from a partial destruction. Without insisting upon this matter, as I do not mean to question the existence of absorbent vessels, it is sufficient to remark, that though a part may be absorbed under a state of disease, or though an absorption of the fluids, extravasated into the cavities, may be perpetually going on, we are not therefore to infer that the absorption of the solid particles, those which are impacted and coherent, is unremitting in health. Is there then, I would ask, any proof that the particles now identically constituting the solid fabrics of the body, do not remain or preserve their places as long as life lasts, unless disturbed by processes of disease?

§ 26. To this question *it may perhaps be replied*, the incessant attrition between the fluids and the solids in the work of circulation must *necessarily* produce the decomposition of the solid particles. If this is *necessary*, then there is no more to be said about it; but that it is necessary, I am inclined to question on the following grounds:

§ 27. 1st, That our experience of the effects of attrition, in decomposing solid particles, is only among such as cohere by a common property of matter; whereas, in the animal structures the bond of union is of a different kind, it is by the force of the organic spirit, which we know to be so far efficient, that it resists the chymical tendency to decomposition, which, as it prevails after death in a shorter time than that in which a mechanical agency, as by the attrition of the fluids, would accomplish the same total waste; we must on this account conceive the spiritual power of aggregation to be equal to counteract the weaker, if it is sufficient to counteract the stronger, tendency. The case is different in disease, where the bond of union is perhaps the first to be affected, and then follows, very naturally, such a change in the cohesion of the textures as is agreeable with the change of the medium which unites them.

§ 28. 2nd, That the power of mere attrition is not sufficient to decompose the solid particles seems to be further indicated by the following consideration, viz. during the periods of growth solid particles are actually laid down and cohere with the rest; now these particles existed in that fluid which afterwards performs the attrition upon them. If the affinity which aggregates these particles is

sufficient to fix their place, when they are already in motion, we can scarcely conceive it possible that the fluid which could not keep them against this affinity before they were fixed should be capable of *unsettling* them against the force of the same affinity when their coherence has been established: on these accounts, and in this view of the subject, I reject also this testimony. Is there any other proof of the unremitting absorption of the solids?

§ 29. It may be replied, the rapid diminution of bulk by fever, by violent and continued labour, by purgatives, &c. proves the facility with which the solids are removed. Granting these circumstances to be true, they do not prove even that the waste in these instances is occasioned by a function of the absorbents to that end; for the examples are those of disease, of conditions when the principle of life is under preternatural affection, the influence of which, as may be expected, is expressed in the changes of the textures which are governed by it.

§ 30. In addition to the previous observations upon this subject, it may be remarked, that if an absorbent is capable of removing a solid particle, that is, if it is capable of overcoming the affinity which maintains its place when it is once established in its place, it appears unaccountable how the same antagonist function of the absorbent did not resist effectually the deposition of the particle. I shall pursue the general indications on growth by applying the doctrines to alternatives.

§ 31. Now if the two processes of deposition and removal of particles are unremitting, it is obvious that the respective powers must, in regard to the same particles, prevail in succession. From whence it would follow that the relation between the agents is of the following kind. While the organic particles are yet combined in the blood, they are related with the affinity of aggregation; after their separation from the blood they lose their relation with the last-mentioned affinity, and become subject to an agency of decomposition belonging to the absorbents: as all the functions which have ever been demonstrated or fancied to belong to this system (with the exception of a capillary attraction, if any such exists) take place only as the phenomena of the living state, so a relation of the above supposed kind, between the absorbents and the aggregated particles, is directly or indirectly with the organic spirit of the former.

§ 32. Still treating the perpetual absorption of the solids as a supposed fact, the organic spirit residing in different structures has properties which appear to be antagonist: but as it is contrary to every analogy that each should in turn prevail, during an opposition of their agencies, and the more especially as the weaker (the absorbent) prevails after the fixture of the particle, when the common cohesion of matter *acts as an auxiliary* to the force which before prevailed: as this cannot be supposed in consonance with the nearest analogies (facts being almost entirely wanting), so it is necessary to conclude, that when the absorbent function prevails, the relation of the solid particles with the affinity or spirit of aggregation *has*

ceased. This conclusion nearly frees our topic from the embarrassment of the alternatives; it almost reduces our question to one concerning the continuance of the relation between the vital property of aggregation and the solid particles.

§ 33. As the spirit assimilates, although its nature is preserved, yet its present quantum is perpetually passing away. The relation of the solid particles being with the nature of the spirit, and with no identical quantum of it, it again suggests itself in this place that every successive quantum of it is related with its own organic particles; and that therefore aggregation keeps pace with assimilation, which also accounts for the uniformity with which bodies, in a general way, preserve their bulk or change it slowly; which, in regard to the spirit, has been before spoken of.

§ 34. If then the new quantum of spirit operates upon particles of its own, that quantum which has passed away has left the organic particles whose place it was its function to determine, without that aggregating affinity which first laid them down, and which if it continued with, would afterwards preserve, them; and consequently these particles can offer no other opposition to an antagonist agent than that which results from the cohesion common to matter. Thus these particles are submitted to the controul of an absorbent function, or they are separated by a chymical process, being deprived of life: one of these appears inevitable; and as that chymical process which would take place in the absence of any other means of decomposition is one which is never recognized in a living body, during health, so it seems probable that the agency on the particle, begun by the aggregating spirit, this having ceased, is taken up by that of the absorbent.

§ 35. That such a cessation of intercourse between the aggregating spirit and the organic particle does occur, seems probable from the circumstances—1st, of growth, or regular increase, which proves a relation between the spirit and new organic materials, the operation of which we have no reason to think is suspended during health; and, 2nd, from the rapidity with which the bulk of the body is restored after having been reduced by disease.

§ 36. This latter view furnishes an indication that the processes of aggregation and absorption are unremitting; and according to this mode they are not incompatible; and it furnishes also an indication that the spirit belonging to the absorbents is the agent by which the waste of particles is accomplished and the material cohesion overcome. But, as remarked before in the discussion, we have no facts on this subject which amount to proof; and in a former view of a similar question (in the chapter on Assimilation), some objections were cited against the harmony thus exhibited, the force of which was there allowed to prevail.

§ 37. There are many other points belonging to this relation, such as the *period* of the continuance of life with the particle it has laid down? It is not improbable but this might be regulated by a relation of the following kind: every organic particle laid down is

in alliance with a certain quantum of the spiritual elements, and life continues to reside in the particle until its spiritual elements have changed their form by assimilation. The other questions hinted at are, how long may the organic particle be preserved by material cohesion, supposing that the affinity of the spirit with it by change of relation has ceased, and supposing no chymical processes of decomposition (which are not recognized) to interfere? Is the separation of the organic particle accomplished wholly by an absorbent function, or in part, or sometimes by attrition of the fluids, the spiritual affinity having ceased? or do other properties of the spirit contribute to detach that which is no longer possessed of life? &c.

§ 38. These considerations are rather intricate; and unless they are made points of a specific inquiry, in which the recollection would concentrate its efforts upon the facts referring to single particulars, there is no great chance of succeeding with them more minutely.

§ 39. It is therefore best to say, with the degree of assurance which corresponds with the testimony, that the aggregating and absorbent spirits are antagonist; that the one prevails upon a particle as long as the particle is subjected to it; that the particle, by change of its relations, being free, is then submitted to the laws and influence of the other.

§ 40. The growth of the absorbent vessels, as they are called, is in a ratio to that of the other structures. It appears therefore that this structure must be furnished with vital properties of opposite tendencies; that is, while their vital properties are engaged in a process of destruction, in removing the particles composing the textures, they are at the same time occupied in laying down and accumulating (during growth at least) the organic particles which compose themselves.

§ 41. The only intelligible theory of the manner of absorption is that which supposes these vessels to commence with open mouths at every point (so minutely mixed) of the structures. The relation which enforces the function is between the mouths only of these vessels, and the contiguous organic particles. As absorption (with some equivocal and unimportant exceptions) is a process belonging only to the living subject, it is to be inquired what share the organic spirit has in it? The alternatives are two: 1st, it may operate on the organic particle to be absorbed mediately; or, 2nd, it may influence it directly. In the former case it may give the vessel an undulating contractile motion, the direction of which being from the origin of the tube to a centre of connection with others, the effect would be to produce a vacuum agreeing with this course. This in effect is tantamount to a power of attraction, by which loose particles may be received into and propagated along the absorbent vessel. In the latter case the direct influence of vital properties may be an *imitation of the mode*, to a certain extent, which is observed of the *stomach*, namely, that its vital properties are capable of decomposing organic particles which have lost their aggregating

affinity, although they have no influence on those of their own textures, where this affinity is preserved.

§ 42. That one of the above modes, or both of them, comprise the manner of absorption seems probable from these further considerations; 1st, that absorption is peculiar to the living subject; and, 2nd, that with life none of the secondary agencies cease but those mechanical ones which arise from it, the influence of chymical means or the force of capillary attraction being thus in this process of absorption apparently precluded. To pursue this topic any further not being consistent with a design of mere general indication, I shall return to the considerations more especially belonging to growth.

§ 43. While the several orders of the structures increase in a regular manner, the arrangement which they preserve during such a complication of agencies is not the least striking or important circumstance. This arrangement, as well as the election of the materials, has been assigned in a general way to the influence of the organic spirit. As this much has been established in the articles on the ovum, we shall reserve the more precise examination of the influence which belongs to the vital, chymical, and mechanical departments, as a preliminary to the application of the doctrines, to the structures respectively.

§ 44. We have seen how the mutations of the nature of the spirit in the several spheres govern the selection of the organic particles: we have glanced at the laws of spiritual assimilation and endeavoured to connect this process with the formation of the solid fabrics. We are now to consider another act of growth illustrated in the instances of *regeneration.*

§ 45. We find that the regenerative powers are liable to considerable variety. In the higher order of animals they are exerted comparatively but to a trifling extent; in them the most remarkable specimens are exhibited in the union of divided parts, in the extension of bone, by which an interspace, probably of two, three, or four inches may be filled up, and in the healing of extensive ulcers, &c. We have also illustrations of a faculty of growth, not yet considered in the occurrence of tumors, &c. But among the lower tribes the industry of naturalists has discovered specimens of the following description: if the leg of a lizard be cut off, an entire leg will be re-produced; if the head of a snail be cut off, the entire head will be re-produced, furnished with the same organs as the original one, as eyes, mouth, &c. The former fact I have witnessed to a considerable extent; that is, I have seen as much as half the leg of a newt, which was amputated close to the body, re-produced: the whole would most probably have been regenerated, but the animal, from some foreign causes, at this time died. The latter account I take upon trust; and, upon the same authority, a class of animals may be adverted to which are said to be propagated by cuttings. In vegetables a power of production, in effect similar, is still more extensively exercised: thus, a tree, in its general character, and in all the complexity of arrangement, resembling the original

one, is produced from a slip. These instances are the facts upon which our considerations ase now to be raised.

§ 46. The examples may be arranged briefly under the four following classes: 1st, instances of increase of parts not wholly removed; 2nd, instances of the regeneration of parts once existing, but now totally removed; 3rd, instances of disproportionate increase of structures which have sustained no loss; 4th, instances of production of structures which did not before exist. The two last relate exclusively to spontaneous disease: in all four there is an alliance in the laws by which they are governed. The two last, for purposes of distinction, may be called examples of formation; the two first, examples of regeneration.

§ 47. We will define our specimen of increase of parts not wholly removed to be a fractured bone, from which a portion has been sawed off. The interspace is filled up by a substance, in a general way, resembling the bone from which it is produced. By what processes, according to our preceding notions, is this result accomplished? As spiritual phenomena precede the deposition of osseous particles, so these phenomena are first to be inquired after.

§ 48. As we have no means of judging of spiritual identities except by their material connections, so it is necessary in this case to infer, in agreement with a simple extension of structure, a simple increase of the spirit which produces it. The solution so far is easy. The spiritual elements existing in the blood are capable of supporting the quantum of the spirit attained; if the quantum of the spirit is diminished by removing it, along with a portion of a fabric, which it before inhabited, or by abridging its sphere, the elements in the material being capable of supporting the original quantum, will actually attain to it, by the assimilating process, on that which remains; and the same is to be said of the organic particles. Supposing therefore, as in our present example, that there is 1½ inch in the os brachii to be filled up, there is in the material brought to the repairing extremities an excess of the elements by so much as the support of the lost portion would have required. These then are made life by that process of assimilation which has been before said to result from the relation between the elementary and the living spirit; as this is a mere act of growth, the spirit regenerated by assimilation has the same dispositions, the same affinity with the solid particles as that belonging to the rest of the bone and which originally formed it. Hence (liable indeed to some modifications) the regenerated portion resembles that which was lost.

§ 49. But although the law just mentioned may be true to a certain extent, yet as a general one it is not in agreement with facts; for if the remaining agents of a structure are capable of assimilating and of re-producing the same extent of structure as was originally maintained by the material with which it was supplied, then should three fourths of a femur, removed, be re-produced, and grow from the remaining fourth; for the material was adequate to maintain *such an extent of bone.* Nay, further, in agreement with such rules, a

thigh which is amputated three or four inches below the hip, should be re-produced, bone, muscle, and skin; for an original or a nucleus of all its parts being left, the whole should be regenerated, if reproduction were commensurate with the elements.

§ 50. Although therefore the preceding account may shew how some of the necessities of growth are supplied, it by no means declares the laws by which the whole process, its varieties, &c. are governed. The interspace of a fractured bone may be filled up, yet the bone after amputation does not grow. The interspace occasioned by the removal of a portion of a nerve, or even of an artery, may be filled up; a *certain extent of breach* might be repaired, but not *any extent.* Then again, although there might be supernumerary elements in the material, corresponding with the amount of the textures which originally existed, yet it does not follow, except from laws nct adverted to, that the increase of assimilation and of organization should take place *where the chasm is to be filled up,* rather than in any other place, seeing that the blood which circulates in the vessels of the repairing surfaces is common to all other parts.

§ 51. These facts suggest the theory that the constitution of the life of respective parts tends to preserve a *continuity*; that if this continuity of life is interrupted by the removal of a portion of structure in which it resided, *then* the continuity is restored from the repairing surfaces; that this tendency to the establishment of a continuity results from an affinity between a similar constitution of vital properties, which belong to the same structure, by the force of which, an *interrupted principle tends to coalesce;* that this affinity has certain limits, or that the affinity does not obtain if the interrupted portions are too distantly removed. Thus, to illustrate this theory by an example, suppose four inches of a nerve to be removed, if the principle residing in the divided extremities is too widely interrupted to admit the operation of the affinity, by which these properties were in the ovum first assembled together, the breach of continuity remains; but if one inch of a nerve were removed, the affinity then operating, the continuity of the principle, or of the organic life of the nerve, would be restored; and in this process either the two portions or extremities must suffer a diminution of the quantum of the principle, corresponding with *its extension,* or their assimilation must be increased. The continuity of the principle, however, under these circumstances, being from the power of this affinity restored, the aggregation of a corresponding structure must proceed in consequence in a ratio to the assimilation of the disposed spirit in this seat, and to the organic particles supplied, from whence the slow process of growth or regeneration.

§ 52. There is another remarkable property in this affinity of the life of a structure, viz. that where a chasm is to be repaired, it supersedes a spiritual constitution of another kind, and destroys its correspouding organization. Thus, though the interspace of a nerve may be closed by the union of surfaces, or by granulations, yet the

portions of nerve will approximate and finally unite, while the foreign substance which impeded this union is absorbed in their progress towards this end. It is impossible to develop these mysterious relations: it may however be suggested, either that the precise living principle of the nerve has a power of conversion with respect to that of the intervening texture; or, that as the former increases by assimilation, it engages, from the superior affinity which may belong to it, as its proper sphere, all the elementary properties which can subserve to assimilation *in this seat;* thus, of course, compelling the extinction of any other assimilating form of life. This suggestion gives rise to another alternative with respect to the time in which the continuity of the principle of an interrupted nerve (or other structure) is restored, viz. that it is only in a ratio to the increase of the principle from the extremities, and a corresponding or synchronous formation of the structures.

§ 53. Our plainest inference therefore seems to be,(the regeneration of lost parts being limited in its extent; being also subject to much variety, and each view involving some difficulties, not to say contradictions;) that processes occur in growth, which are distinct from mere assimilation and its consequences, or which give additional complexity to this process and these effects.

§ 54. The subject of organization, or re-production, is one upon which much vanity has been expended. Every one can explain it, and yet no one has even conceived a difficulty belonging to it which would puzzle a mere simpleton. It is amazing how men can flourish, and strut, and talk, and write, pompously and dogmatically, upon subjects about which they know nothing; when at the same time an *assumption of knowledge* is made the basis of their impudence and importance. But as the world is civil enough to allow men to pass only for what they assume, it is no wonder that those who know the least, should find it necessary to assume the most. Those which are called the doctrines of adhesion, re-production, &c. are boasted doctrines; it happens however that they are no doctrines at all, or else the doctrinal parts are of a new and curious kind: union by the first intention, &c. the healing of an ulcer, &c. this is how they are spoken of; a medium of coagulable lymph *is thrown out,* and vessels *shoot into it;* or granulations are *thrown out,* the ulcer is filled up, and *then skins over.* I can discover no doctrine here, except it is designated by the words marked in italics, to wit, the *throwing of lymph* and granulations, and the *shooting* of vessels; the detail is simply one of sensible effects which are different from doctrines. This detail is short, simple, easily come at, and, above all, for practical uses, highly valuable; but if we would have some doctrines upon the subject, we must consider the throwings and shootings only as short, convenient expressions, and seek deeper for a clue to the explanation.

§ 55. In conformity with the preceding views (upon which I presume no further than an evidence, at best doubtful, warrants)

the following appears to be the mode of re-production: by a function (or by certain properties) of life a secretion is produced from the surface, or the place whence the new organization commences: this secretion is lymph; by assimilation life is increased in this place, and its sphere is extended; but for the lymph previously effused, life, wanting an alliance with the material, would be dissipated, but the lymph being effused, life as it increases, occupies a determinate sphere, allying itself with matter, which is done by an affinity before mentioned. The life produced is conformable with that which produces it; thus, the life of a tube occupies, or by progressive change assumes, a tubular sphere (this is settled by relations mentioned in the article on the ovum), and by its tendency, whether as to place or properties, the organic particles which it claims, or separates from the material, are laid down: in this case it may possibly have a double source of the organic particles, as well as of spiritual elements; for we have reason to think that both are possessed, as well by the lymph already effused, as by the blood or circulating fluids, each alike wanting the influence of life for the consummation of a final purpose.

§ 56. That the lymph is prepared previous to organization, seems to reflect some light upon a former question, viz. whether particles are separated from the blood during assimilation or afterwards? The fact just mentioned indicates the latter, which has been before thought the most probable: for if life aggregated particles at the time of assimilation there would be no need of a medium for its reception, seeing that it and the particles might grow together from the surface whence the organization begins. We next come to consider the second class of the instances of regeneration, viz. of parts once existing, but now totally removed.

§ 57. We have found but little difficulty in getting a conception of some sort of the mode of regeneration in structures but partially destroyed, our notions of growth have helped us nearly to a solution in this case; but by what processes of the agents of growth are parts, wholly destroyed, re-produced, as from a nucleus in a *distinct texture?* Thus, in the regeneration of a limb, a muscle is begun and developed to its proper extent, or a bone grows in a cylindrical form, and at a certain point osseous growth ceases, and cartilage is produced, and then proceeding on from this texture, or by mediate connections, bone is again generated, as in the entire formation of a new limb; or, in the case of a snail which has suffered decollation, from the trunk proceeds the neck, the head formed from the neck: in the progress of organization, the mouth, the lips, &c. are developed; or, in vegetable re-production, a slip puts forth shoots, these at one period smooth and similar throughout, at another at certain places forming branches, &c.

§ 58. As the regeneration before described refers to the production of resemblances, so its processes of vital properties are chiefly those of assimilation; as in the latter cases the production

is that of dissimilars, so this work is conducted by laws of constitution. We have hitherto considered the spiritual changes to precede and govern those of the organic materials; the former therefore are to be considered first.

§ 59. The identity of the spirit is determined by its properties: some of these properties are latent and others active. The properties composing the spirit in any sphere are liable to spontaneous change, or that which has been before designated in this department progressive causation. It is by the occurrence of these acts that properties before latent are often made manifest, while those before existing are no longer recognized by their effects. This law is illustrated in the instances of conversion, which are endless. Now these latent properties produce that which is called pre-disposition: the conversion of latent into active properties happens in the same way as all other changes, that is, there exist in this case many related agents, making collectively the entire spirit. These agents, not agreeing in a permanent combination, are liable to become variously combined and modified at various times, producing at these times varieties in the phenomena which result from them: thus the testes at the period of puberty begin to secrete; thus cartilage is converted into bone, or an attack of gout occurs, or an artery is ossified, or a membrane, as the dura mater, is converted into bone, &c.; thus also, and more allied with our topic, a fractured patella produces ligament. These things arise from latent causes, furnishing pre-disposition, and becoming active from change of relation between constituents, determined by the force of causes. So much by way of recapitulation.

§ 60. The difficulty then in regard to our present question is not to conceive why dissimilars are produced from established textures, but by what law these dissimilars should assume the form of parts which are removed? We have no hesitation in referring the former to an act of constitution among the spiritual properties, which will be sufficiently intelligible from what has been already said about it: but the latter we must trace more minutely.

§ 61. The difference in these three cases of growth is this: the first is simple increase by assimilation, the second is increase accompanied with change, the third is increase accompanied with change, tending to produce the resemblances of parts totally removed. Now these three follow one law of causation, that is, the processes are according to the relations between the spiritual properties among themselves and the allied materials. As these agents determine the process, so the consequence is that which it is determined by properties possessed already, and by no new accessions.

§ 62. Hence it appears to follow, as the spiritual properties of an existing texture are capable of forming a different texture which is removed, that the spirit possesses properties in its different seats which are common to all or to many, or, relying on our present data, to *some others*. From whence it will follow, further,

that the tendency of the internal causation of the spirit is, working with common properties, to produce different forms of it in different spheres, by which changes of forms, properties, in regard to the textures, become either active or latent.

§ 63. Thus, if a lost muscle were regenerated, the processes from the surfaces whence it proceeds would be of the following kind: properties capable of forming the muscle are possessed in a latent form by surfaces from whence it grows; by the relation between properties, life is increased by assimilation from the material in the way described: but the life thus increased, instead of being identical with that inhabiting the textures which originate the new growth, is according to that modification of the spirit which, from the force of internal relations, it has in this place assumed. The production will depend upon these internal relations, and by them, according to preceding data, it will be bone, muscle, ligament, lips, eyes, or any thing else. It is however proper to observe, that where the regenerative processes take place to the greatest extent, as in the lowest tribes of animals, and in vegetables, the new production often differs but very little in the character of its organization from that whence it proceeded, or indeed from the entire mass.

§ 64. In the examples of morbid growths, as of tumors, conversions of structures, &c. a similar proceeding is observed: the organic spirit assumes a change in its properties, by this change the condition of the textures is affected; perhaps the seat of the disease might be a small congeries of capillary tubes, from them processes of growth originate, and the character of this growth is determined by the disposition of the spirit which inheres with it. Thus we might have a small sarcoma with no tendency to increase, or the spiritual properties may dispose it to a rapid increase; having attained a certain bulk, a new spirit may appear to actuate the mass; from a tendency to regular increase, partial acts of destruction may take place, it may slough, it may suppurate, it may throw out a fungus, its vessels might give way, &c.

§ 65. Now with respect to this change which has taken place in the tumor, the common phrase is, it has assumed a new *action;* and if on a sudden it *mortified*, would this be a new *action* too? Let, however, the term pass, as it is one of easy and established use. For my own part, a word will not in such cases content me. But, according to this term, the fate of the tumor is allowed to be determined by a government of a vital kind. What then is the law by which this new action (I have a great antipathy to the word) takes place? Previous to its occurrence, the tumor was tranquil, and it maintained the cohesion of its structure; this must be imputed to the condition of the spirit: the structure is afterwards modified or destroyed; this also must be attributed to the condition of the spirit.

§ 66. Now the tumor being at the time of change, as before, supplied with blood made by unaffected organs, the change can

arise only from that tendency to progressive causation between the spiritual properties, which when the change is related with, is followed by corresponding changes of the structures.

§ 67. If, without making any reference to the spiritual agency, we should say that one modification of the structure succeeds to another, until some final state was accomplished, we should then express no more than we see; but our inferences teach us to make this reference. We say in the gross, the *tumor* has a certain predisposition; analytically, we say the spirit which precedes and governs the textures, has a certain predisposition; pursuing the analysis further, we say this predisposition is constituted by latent causes, by spiritual properties, possessed, but, in respect of their relation with the structures, informal.

CHAP. IV.—*Animal Heat.*

§ 1. ANIMAL heat is distinguished from every other example of heat by the circumstance, that it is maintained only during the living state.

§ 2. The term *animal* heat is perhaps not altogether unobjectionable: because we find that the living structures possess an elevation of temperature, where the characteristics of *animal* life, namely, sense and voluntary motion, are wanting; while, on the other hand, the generation of this heat does not proceed after the extinction of the *organic* life. The term *vital* heat would perhaps be therefore more correct; but as this is a matter of very little consequence, I shall not affect peculiarity by insisting upon the distinction.

§ 3. Animal heat being produced only so long as life continues, and the chymical and mechanical agents in the structure, shewing of themselves no disposition or ability to produce it; we must infer, from these facts, that that principle of life, we may according to the last paragraph recur to our old phrase, and say, that organic spirit hitherto spoken of, is in some way or other concerned in the process of generating animal heat; and that heat so far acknowledges a dependence upon this spirit.

§ 4. The formation of animal heat results either from the function of some particular organ or organs; or the process is a diffused one, as universal in the structures as the existence of the spirit itself: the settlement of this point is one of importance.

§ 5. Now that heat is not produced especially or exclusively in any one place, and from thence diffused all over the body, appears to be satisfactorily proved by the following circumstances: 1st, the medium of such diffusion must be either by the continuity of the solid structures, either single or mixed, or by the circulation of the blood. In either case, supposing, in illustration of the first, that the central organs of the nerves are the source of heat, and their branches the medium of its diffusion; or, in illustration of the second case, that the lungs are the source of heat, which is in them imparted to the blood, and by it to the textures; I say, in either case, the temperature of the place, or source, where heat is generated, should be considerably higher than in the places of its remotest distribution. Thus, supposing heat to be generated only in the lungs, these organs bear perhaps in regard to the whole,

the proportion of one to forty: now the perpetual tendency of thirty-nine parts in forty is to become cold; the blood therefore in the lungs should be at least many degrees hotter than that which has reached the extremities, and which has imparted heat in its course to structures so much more considerable than the organs by which the heat was produced: and the same is to be said on the supposition of any other source of heat; whereas there is in fact no regular and assignable difference in the temperature of blood at different places.* This fact seems a sufficient refutation of a local *source of caloric*, while, if the fact were otherwise, it would prove only a variety of temperature at different places; but not that the seat of the highest temperature was the source of caloric to all the rest; unless it were first shewn that the increase of temperature in this seat was adequate to such a purpose, and unless there was no reason to suppose that the faculty of producing heat was elsewhere possessed.

§ 6. That heat is not conferred upon the structures by any medium, as from a source, seems also to follow from the irregularities of temperature of different surfaces, either spontaneous or producible by artificial means: thus I have known the temperature of a paralytic arm generally, I believe always, lower than that of the sound arm in the same subject; thus, also, a division of nerves will reduce the temperature of a limb, perhaps permanently, or at least until re-union of the nerves has taken place, or their function is otherwise supplied. The same consequence has succeeded to the ligature on the arterial trunk of an extremity. Both these instances *conjoined* prove that heat has a *diffused*, and not a precise or exclusive, source; and that the degree of it is liable to be affected by an agency upon parts which are intimately connected with the vitality of the structures. Conceding then that heat is formed in no single organ, but is a function common to all structures (or some of their components), it is next to be inquired, by what process this evolution of heat takes place, or what relations are engaged in the process?

§ 7. In speaking of the fecundated ovum, we have seen that the ovum of viviparous animals commences immediately after fecundation, the processes which establish fœtal existence; while in oviparous animals the ovum may wait a considerable time after fecundation, and the same processes are never commenced in it until it has acquired a temperature which it afterwards maintains.

§ 8. It appears therefore that heat is essential to life, that the ovum of viviparous animals, suffering no interval between fecundation and the acquirement of heat, immediately begins the *characteristic acts of life;* while the ov~~um~~a of birds, &c. do not begin these acts until their life is adapted for the purpose by ex-

* *It is said* that the temperature of blood is raised two degrees by the conversion of venous into arterial blood: this increase of temperature, however, if true, may be easily shewn to be inadequate.

ternal warmth. Hence it is to be inferred, that the identity of a living principle, at least among the animals which afterwards display the possession of vital heat, is not perfected but by the influence of heat.*

§ 9. As processes of life are commenced by the influence of heat, as heat and life are invariable accompaniments, the one not ceasing as long as the other continues; but more especially as the vitality of the egg is no more than a *predisposition to the living state*, and as heat perfects it in this state and afterwards remains with it; we must infer from these facts, as well by general consent in matters of reasoning as in consonance with the laws of causation, that heat is an essential property belonging to the common living principle; that heat *unites* with the other properties of life, which, in the egg, were before only predisponent, and that the identity of life is thus *conjointly produced.*

§ 10. It has been shewn that life is so related with its elements in the material, as to be able by *uniting them* to produce its own resemblance, which has been called *assimilation.* Now if life has an assimilative relation with the elements, *heat being a part of life, is also maintained in the same way;* that original heat which was conferred on, or belonged to, the life of the ovum, is that which, continuing with it and growing with it, afterwards *maintains, in conjunction with it,* the phenomena of *animal* heat; no circumstances of which are not explicable by a reference to this union in its regular or modified conditions.

§ 11. That heat, like the other properties of life, is maintained by assimilation, is shewn by the same proofs as those which establish this mode, as belonging to the general principle. The proofs may be enumerated as follows: 1st, the chymical and mechanical parts of an animal, life being extinct, become rapidly cold; they therefore have no relation among their agents, which will produce heat; 2nd, life exempt from heat (as in the ovum, &c.) cannot produce heat, though subjected to the same substances in other respects; 3rd, heat united to the living principle produces heat. The first proves that the composition of the structures cannot produce heat; the second, that the other properties of life cannot produce it; the third, that it is instrumental to its own production. This seems tolerably clear.

§ 12. But the relation of the heat forming a part of the spirit, is not simply with its own elements, for heat conferred artificially upon dead textures, although the same elements be exposed to it, will not be produced, any more than life will be produced without heat.

§ 13. Hence it follows, that the relation between heat and the other properties of life is this, namely, there is an affinity between

* That certain forms of life operate without heat, or but an inconsiderable degree of it, as among cold-blooded animals, and vegetables, proves only that life, existing in different forms, has its peculiar efficacy, dependencies, and relations, respectively in each.

them, by which they originally unite, to form the identical living principle; this affinity afterwards preserves their union. In the material which is subjected to the agency of life are the uncombined elements of life, otherwise said to be latent: there are also the elements of heat which are latent. Now the affinity of life with the materials is with its resemblance or its constituents; heat is included in this affinity, and is *assimilated* as a part of an identity, the force of which is to produce itself, by an operation upon a material which contains its elements. On this point I have scarcely asserted more than the order of occurrence, which is almost subjected to our observation.

§ 14. There is a close resemblance between the manner in which life and the highest degrees of heat are maintained: in both the process is one of assimilation, and consists respectively in the union of its elements. Ignition does not take place from the contact or mutual exposure of that which contains the elements of fire. Thus, wood or coals existing in oxygen would never inflame; but fire assimilates itself from both, and, like life, is perpetuated by the union of its elements, before separately existing, or otherwise combined.

§ 15. Fire has another agreement with life, namely, that in each the elements are combined from the two sources of earth and air.

§ 16. But with respect to the generation of *animal heat* there is a difference between this process and the ordinary one of its ignition. In general, the elements are assimilated only by that which is actually ignited: a heated substance of 98 degrees is not capable of assimilation. But this animal process can scarcely be expected to be of the common kind, when it can take place only by so peculiar an associate as that of a vital principle.

§ 17. That elements of this heat are contained in the blood cannot be doubted, because we find that the blood is inflammable, and also, that by the blood the animal heat is supported; not by blood itself simply, nor by the other properties of life as related with blood, nor by heat, as related either simply with blood, or the other properties of life, *but by a relation which involves them all.*

§ 18. To say precisely the share which each of these has, or to trace the mode which the relation observes, more minutely, would be at least difficult, or perhaps, without a progressive refinement upon these views, impossible. So much however has been said as appears to be sanctioned by facts.

§ 19. As animal heat cannot be produced by the other spiritual properties, heat being absent, so heat precedes and governs its own production, and is not, as has been supposed by the chymists, a mere effect of other agents, a product altogether independent of itself.*

* Spontaneous ignition sometimes occurs: this is a point of analogy with the origin of life by constitution; as the ordinary instances of ignition are analogous with the perpetuation of life by derivation. In the animalization of crustaceous ova, the origin of life by constitution, or its creation, is partially repeated.

Indeed the subject of animal heat, as is well known, never has been and never can be explained by chymical analogies; for the agents of chymistry, though necessary, are rather of a secondary and subordinate kind. Not but that chymical changes and processes must happen in the performance of the function we are considering, but the true ones remain to be investigated, and require that the more essential agencies should be taken into the account. Blood, in parting with the principles which are reqnired or compelled by the other properties of life, cannot in this way yield heat; or extraneous heat would be unnecessary to begin processes of life, in a body which possesses *within itself a capacity to produce it.*

§ 20. There is also another point of analogy between the functions of calorification in animals and vital assimilation: they are each supportable only by arterial blood. Here again we are reminded of the elementary sources: blood made from food, food from earth; arterial blood, made by food and air; arterial blood supporting life and heat, or we may say only life, as heat is an essential or constituent part of the common *forms* of life; arterial blood, having supported life and heat, has lost its elements, or at least those from air, and becoming venous blood, requires a new constitution to become again the supporter of the organic spirit. Some further considerations connected with this topic will fall under the titles of "preparatory functions, blood, &c." What is here said will not be properly estimated unless it is connected with every peculiar view of relations before expressed.

CHAP. V.

General Relations of Vital, Chymical, and Mechanical Agencies.

§ 1. THE relation of the spirit with the chymical substances has been hitherto described as one of affinity. That it is not one of constitution, or that the organic chymicals are not made by union with spiritual properties in the way of constitution, is proved, 1st, by the fact that the spirit preserves its own identity, and is not lost in combination; and, 2nd, because the structures, &c. remain, when the identity of the spirit has ceased; which would not be the case, *if this precise identity were an essential constituent.*

§ 2. The chymical alliance with the spirit begins in the ovum: this substance is selected by the properties of the spirit which reside in it, and but for the influence of the properties by which it was formed it would not be maintained. Hence, a form of life, which is only a predisposition to that which exhibits the living phenomena, is capable of maintaining the coherence of organic particles; and it is this property which establishes its character as a form of life.

§ 3. The chymicals with which the spirit was from the beginning allied, or rather the repetitions of similitudes, perpetuating the relation, *concur* as long as life lasts to preserve the living principle, by assimilation, &c.

§ 4. The relation of the spirit with the mechanical department in all the processes of formation and growth is mediate, that is, the alliance of the spirit is with substances composed of certain chymical properties; these properties form the material substances, and as the relation of the spirit is with these precise properties, so those precise substances which they compose are the result of its agency. The proof of this is the necessity of *precise chymical materials* which would not exist *if the spirit were directly related with properties common to all matter.*

§ 5. Foreign chymical properties influence the spirit both directly and indirectly. This, however, is rather inferred as probable modes of its influence than proved by any example, because we have not the means of discriminating the instances, supposing there to be many of both kinds. It is therefore inferred, as the spirit is related with the agents of chymistry, that it might become affected

by external or foreign ones of the same class—1st, by a direct relation which the spirit might have with these foreign properties; and, 2nd, by a relation which the foreign have with the natural chymical properties; an established relation between these latter and the spirit already existing, the spirit may be modified or influenced by the disturbance of the chymical agents which help to form this established relation.

§ 6. As the chymicals are selected by the properties of the spirit, and as in the living body no chymical process (unless one to be mentioned hereafter in the lungs, &c. be an exception) takes place which is not under the government and direction of the spirit, so it follows that *no primitive spontaneous change* can take place in the chymicals, but that such change must happen by a previous one of the spirit. Thus, the chymical nature of the urine may be very different at various times; it may sometimes contain substances of which at others it is entirely destitute, or the proportions of substances usually belonging to it may be variously altered. Thus, also, calcareous depositions may be formed in the coats of the arteries, or about joints, in parts which have been the seat of gout; thus, also, exostoses may be produced, or mucus secreted, or matter secreted, or gelatine secreted: all these may exemplify chymical changes, but the chymical change in either is not primitive; for, withdraw the influence of the spirit, let this principle be extinct, and they none of them take place. Whatever may be the disposition of the chymicals at the time of its extinction, they are from that period inactive: they form neither urine, nor chalk-stones, nor bone, nor mucus, nor pus, nor gelatine; but they agree in one common tendency, to separate from each other by putrefaction. Hence they are held in a forced allegiance, and the spirit is the bond of their union. And as the identity of the spirit produces and maintains a corresponding identity among the chymicals, so the deviations of the one are productive of corresponding changes in the other.

§ 7. If there are any exceptions to the truth of this remark, as hinted above, they will be found in the phenomena of the preparatory organs, where substances foreign to the animal economy are liable to be received, and from the circumstance of their having no relation with the spirit by which they are placed under its controul, run into processes agreeing with the relations subsisting between themselves, and by the results of these processes may possibly find a relation with the spirit, so as to place it in the situation only of a re-agent.

§ 8. But the agents of chymistry may be primitive in affection, when they are introduced from without; in this case these agents are foreign, and their phenomena are not to be enumerated under the title of spontaneous change.

§ 9. Consistently with the laws of causation, there might be predisposition to change in the chymical constituents, and this predisposition might be excited under the continuance of an unchanged state of the spirit. But, in this instance, the change in the chymicals

is not primitive, for the predisposition which leads to the change is preceded and produced by one of the spirit.

§ 10. The spirit has also the *additional indirect* relation with the chymical through the mechanical department. This relation is exemplified in all cases in which the natural relation between the spirit and the mechanicals is disturbed; and the effects of which are afterwards communicated to the chymical connections. In this way it is exemplified in wounds, and in all mechanical injuries in consequence of which the spirit is affected, and then modifies the structures or the secretions.

§ 11. The relation between the spiritual and mechanical, as before remarked, cannot be distinguished from that between the former and the chymical department, in processes of growth; because the particles which compose the structures are constituted by chymical properties.

§ 12. But this relation, namely, that between the spirit and the mechanicals, may be considered according to the following division: 1st, the spirit with the material particles, as a power by which their place is assigned; 2nd, as a power by which they are moved; 3rd, as the spirit is influenced by their place; 4th, as the spirit is influenced by their motion. These four divisions include the modes by which the properties of matter are acted upon and operate in the constitution of animal bodies.

§ 13. 1. The first has been already sufficiently remarked upon: the chymical constitution of the particles interfere to prevent a precise distinction.

§ 14. 2. The power which the spirit possesses of giving motion to the material parts is copiously exemplified. This power is exerted in the motion of the solids belonging both to the organic and the animal departments, and in the motions of the fluids. The relation of the spirit in producing motion is with the structures, by which latter, motion is communicated to the fluids; in some instances the affinity of certain fluids with the spirit may be a cause of their motion, but to what extent is not ascertained. The properties of the spirit have their seat in the minutest spheres of the textures; their alliance is not simply with particles possessing the common properties of matter, but those precisely formed, as we find them, by chymical constituents. It is therefore probable that the relation of the spirit with the textures, by which the motions of the latter are occasioned, is not *directly* with the common properties of matter, but through the medium of peculiar constituents belonging to the matter, and which, as they are found united with chymical materials, can scarcely be separated from this class.

§ 15. We find that mechanical agents, which produce sensible effects upon the principle of life, belonging to either system, produce these effects through the medium of the established textures. This relation between organic and foreign matter is one which requires contact; and by contact the influence of foreign matter is comprised in the modifications of pressure, which pressure, so far as the

mechanical structures are concerned, is to produce merely a change of place, *some modification of continuity.*

§ 16. In order to be satisfied of the truth of this principle, we have only to consider what would be the effects of mechanical agencies upon the textures, whether internal or external, under a privation of the spirit which is allied with them. A needle thrust into the flesh during life produces pain; life extinct, its effect upon the textures is to displace coherent particles: a piece of glass buried in a living muscle produces pain and all the phenomena of inflammation; in a dead muscle, it merely separates fibres which were before attached: a stone in the living bladder occasions excruciating and complicated disease; in the dead bladder, the stone rests upon its coats, producing a pressure according to its weight, modified by its shape and asperities.

§ 17. If we would understand how the spiritual properties are affected by these mechanical agencies, we must ascertain what is the nature of the relation between these properties and the place of the organic particles.

§ 18. Now it is obvious that an organic particle, being merely the seat of a principle of life, can in this relation impart no influence to the principle which it contains; by which is further meant that without the intervention of some other agency, provided the particle continues to retain its portion of the principle, the latter cannot be affected by any change which the former might undergo. Thus, to return to one of our examples, if a needle should be thrust into the flesh, its effect upon the mechanism is to separate particles which before cohered; the particles separated being still possessed of their vital properties, possess them in one place instead of another, and in this simple mechanical relation no further change can happen in them. But in the living state further changes do happen in them: pain, inflammation, &c. result in structures where these did not before exist. But, as just shewn, these phenomena cannot arise from the *mere mechanical relation;* it is then to be investigated by what laws they do occur.

§ 19. As the solid particles are the respective seats of corresponding spheres of the spirit, so by a change in the relative situation of the particles a similar change is produced in the relative minute spheres of the spirit.

§ 20. If it can be shewn that the spirit in the minutest spheres is essentially related with contiguous or distant spheres of the spirit, we shall readily conceive how the condition of the spirit may be locally disturbed by an operation upon the textures.

§ 21. The truth of this spiritual relation is confirmed by the following facts: 1st, the function of a nerve, for example, is modified or lost by mechanical injury, or mechanical interposition, proving that a faculty residing in a particular seat is not perfected in that seat, but has a remoter dependence; 2nd, the influence of a mechanical injury is not confined to the seat of such injury, but is participated in both by contiguous and distant spheres of the spirit;

3rd, that the life residing in a minute sphere is related even to a limited or circumstantial *dependence* with that of adjoining spheres, is also proved by the circumstance that although the mechanic arrangement of the textures might be preserved, and its chymical qualities also either preserved or conferred by imitation, yet the life of this piece of structure will immediately become extinct on its being removed from its connexions. Indeed that the properties of life existing in any seat are perfected by and related variously with the vital properties of other seats, is perfectly allowed, and the modes of the relation will be hereafter considered.

§ 22. This truth being established, viz. that the relation between vital properties is according to their states in respective spheres, it follows that the spheres of properties cannot undergo a change without a corresponding derangement of the phenomena which result from their natural relation.

§ 23. As these phenomena, in the natural condition of the structures and their alliances, constitute the state of health, so those which result from an unnatural condition, whether primitively of the mechanical, of the chymical, or of the spiritual agents, comprise the state of disease.

§ 24. But although the relation just mentioned should be freely conceded, it will be inquired whether the influence of external mechanical agents upon the spirit may not be of the *direct* kind? To this question it can only be replied, that it disagrees with our nearest analogies to suppose that mechanical bodies can affect spiritual properties in the way of constitution, that is, by imparting constituents, or in any other way than by producing indirectly new relations, or destroying those which are established.

§ 25. The examples of our nearest analogies may be drawn from among invisible fluids (or those even of a grosser kind). Thus, a solid body placed in air or water has no quality to change the fluid which surrounds it: it is only an interposition which *interrupts the continuity of the medium it exists in.* The same thing happens with any of the gases, the nature of which is not changed by any mechanical agency, though it may be possible that it should be changed by the *chymical* properties existing in the mechanical agent, provided there is a relation subsisting between them.

§ 26. But the case is different where the relation of mechanical agents is with others of the same kind, with which latter, properties reside whose natural identity is dependent upon a state of continuity and a free communication with related properties. In this case (which is the case we are considering) an external mechanical agent operates in the following order: the foreign mechanical, related with its resemblance in the textures, produces a corresponding effect, which is comprised in change of place, either simply affecting the line, or the existence, of continuity; the particles of the textures, thus displaced, containing chymical properties; these following the fate of the substances in which they are embodied; the chymical properties having in alliance with them spiritual ones, these latter

holding a relation liable to catenate changes with contiguous or distant ones of the same kind; and being in this manner united with the textures, participate, according to their own relations, in the changes which the textures might be made to undergo.

§ 27. 4th, The motions of the mechanical alliances can affect the spirit only in the way of re-agency; and the supposed instances of this are rather of a doubtful nature. Thus it is one of the effects of that state of the spirit constituting fever, to accelerate the movements of the heart, and to produce a rapid circulation. The fluids, in this case, having an increased impetus, may pass into channels which before received those only of another kind, and in this way, from the relation spoken of between the spirit and the chymical nature of the fluids, the former in these places may be affected; or the process of the material aggregation mentioned in the article on Growth, may be impeded by destroying a balance which we have supposed to exist between the *motion* of particles destined for aggregation, and that power of the spirit by which the place of particles is fixed and their impulse of motion counteracted (which *agrees* with the reduction of bulk consequent upon fevers, though I will hardly call it an explanation of this circumstance).

§ 28. It has been common to consider this rapidity of circulation as the cause, rather than the effect of the febrile state; and in this view the cure is designed by diminishing the action of the heart; and this design succeeds because the action of the heart is diminished by means which first influence the state of its moving powers, restoring them from the modified to their natural state. But how far the rapid or slow motions of the fluids may be capable of influencing the state of the spirit it may be difficult to decide. Indeed the most that we can do with the facts which we possess is to allow that some sort of relation of this kind might subsist; though I see many indications by which even the existence, to say nothing about the assigned phenomena, of the relation, may be brought under doubts. The leading particulars of the relation comprehended in the preceding discussions may be summed up as follows:

1. The spirit produces the chymical materials both of the fluids and of the solids; by which is meant that materials are combined or aggregated by the agency of the spirit, which, without this agency, would be neither combined nor aggregated.

2. The spirit is *directly* related with the chymicals, both as the spirit is liable to influence and to be influenced by the chymicals.

3. The influence of the spirit on the chymicals secures their conformity to it, so that, by a natural and healthy condition of the spirit, the chymicals concur for the well-being of the animal; and theirs is a forced concurrence, since no animal condition of them would take place but for the agency of the spirit upon them; and in the spontaneous changes of the chymicals, as these changes are peculiar to the living state, so it is to be inferred that they would not take place but for a previous modification of the spirit in some or other of its seats, the chymicals of themselves tending invariably

to dissolution. The government of the chymicals, their conformity &c. to the spirit, is rested upon proofs before frequently mentioned, which shew that there exists no true causation, such as identifies the spirit with the structures.

4. But the chymicals are liable to become re-agents in spontaneous processes: thus the products of disease, morbid poisons, (which, consisting of chymical materials, and displaying no characteristic phenomena of life, may be enumerated among the class of chymicals,) being produced by processes peculiar to the living body, are capable of affecting the spirit by absorption, &c.

5. Chymical agency, producing animal changes, may be primitive when the agents are introduced from without. In this way poisons kill by inoculation, by being taken into the stomach or into the lungs, &c. In these cases the relation of such foreign chymicals may be direct or mediate in regard to the spirit, as before explained.

6. It cannot be proved that the relation between the spirit and the mechanicals is ever *direct.* If the spirit is influenced by mechanical injury, it is because the relation between the parts of the spirit itself in respective spheres suffers a disturbance, correspondent with the mechanical disturbance; and when the spirit acts upon the mechanical arrangements, it is by its relation with the chymical materials by which these arrangements are composed.

7. The mechanicals may be directly influenced by the chymicals: thus, a nerve or any other part may be destroyed by caustic, or its organization impaired. The mechanicals are influenced by the chymicals, not by a direct relation which external chymicals have with the mechanicals, but by one which the external have with the animal chymicals; these last composing the animal mechanicals, the latter suffer by the influence of a cause, whose relation is with the former.

8. We distinguish in the ordinary substances of nature properties of two kinds: 1st, those which belong to matter, and which together with their agencies are called mechanical: these properties are distinguished by reason of their being common to, or constituting all matter; 2nd, properties which are peculiar to respective substances, and which in each act and are acted upon in a way which is not common to all matter: this difference gives rise to the distinctive appellation of chymical properties or chymical substances. But although there is some sort of difference between these two classes, yet are the relations of each extended by their union; the reason of which is, that a certain alliance or affinity subsists between the common and the chymical properties of matter, so that when either is influenced, the effect of it upon the other will be according to the established relation between them; which relation appears to be very capricious, inasmuch as it is almost infinitely varied in the several examples.

§ 29. It is scarcely possible to give a closer reason for the invariable union of chymical properties with those of matter than this general one, deduced in conformity with the laws of causation,

viz. that all the phenomena which we can contemplate are as they are determined by their proper causes: thus, there are some causes which, uniting in combination, form certain chymical properties; there are other causes which determine the alliance between these chymical, and the mechanical properties of matter. But this appears to be a mere, though perhaps an invariable *association;* for if chymical properties produced in the way of true constitution the common ones of matter, then should the uniformity of the latter require uniformity of the former, which is not the fact; and if the common produced the chymical properties of matter, then as the former are common so also should be the latter, which again is not the fact. Hence we may say safely, that these sets of properties are conjoined in their respective specimens; and proceed to indicate a little further some results of this union.

10. The chymical properties of substances are not capable of being *directly* altered by mechanical agency; this latter may give motion, or it may compress or separate the parts of the former: but if, after a mechanical agency upon the substance, its chymical properties are changed, it will be by a new relation which is opened between them and others of the same class. As when a solid body is extenuated to a mere surface, its atmospherical exposure is more complete, and changes may then occur in it which would not have taken place before, at least, in the same time.

11. But the common appear liable to be directly changed by an influence on the peculiar properties of substances. Thus a solid body by chymical relations may be rendered fluid, or converted into gas; and although in this case the properties of matter would not be lost, but would still be associated with the chymical properties, yet it cannot be denied but, as mechanical agents, the common properties of matter are very different in the two states: in the one it resists the impulse of other substances, or is itself put in motion, and again communicates the impulse of a solid body to others of its own kind; but, after its conversion, it yields to the substances which it would before have resisted, and neither takes nor communicates motion, &c. It may be contended, as I am aware, that all these varieties are only modifications of matter, or of extension; but this doctrine is completely refuted (which is saying a great deal) in the chapter on Causation.

12. The common substances of nature, being provided with these two sets of properties, we find these in animal bodies still more complicated by another class of properties, which are not common to substances considered either in their mechanical or chymical nature, or in both. Sufficient has been said of these properties: it remains only to add, 1st, that spiritual properties are related with others of their own kind; 2nd, that as the chymical are allied with common properties of matter, so the spiritual are allied with both; 3rd, that whereas the common cannot change the chymical properties of matter, neither can they the spiritual; but the class of chymical agents, having in alliance spiritual properties (for they maintain

the spirit), so to this class belongs, with the spiritual, a relation of re-agency.

§ 13. Spiritual properties are directly related with those of their own kind; chymical and mechanical properties, respectively, are related with those of their own kind. Spiritual and chymical properties are united by a natural alliance: hence the relation between them is always direct; chymical and mechanical properties are united, with the exceptions mentioned, by a similar natural alliance; hence they are liable to influence each other, though *not reciprocally in a direct manner.* These three sets of properties are united in an animal body; hence, mediately or directly, the properties of each are liable to modification from the changes which either might undergo.

CHAP. VI.

General Relation of the Spirit with itself in different Seats.

§ 1. IT has been fully exhibited in the preceding pages that the organic spirit in its different seats exercises various properties. The varieties of texture invariably denote variety in the properties of the principle which belong to the textures respectively. These modifications of properties, may be inferred as before shewn, merely from the varieties of the textures; but there are, also, other differences of vital properties in the respective seats which are not indicated by corresponding differences in the composition of the texture, and which shew themselves by other products, as those of secretion, &c. Properties also are frequently manifested under disease, when their existence is not to be detected in the condition of health.

§ 2. These properties, or, as we say, the spirit, existing in the several seats, is liable in each to a relation with that existing elsewhere. It is the design of this section to indicate *generally* the nature of this relation.

§ 3. The relation of vital properties in one with those in another seat, may be said to be, 1st, direct; and, 2nd, indirect: direct, as when the spirit being affected in one seat, the influence of this affection is communicated to that in another seat, without the intervention of any change in the alliances of the latter, whether chymical or mechanical; indirect, as when the function of an organ whose office it is to prepare the chymicals for the use of the spirit in other seats, becomes impaired, in consequence of which the spirit is affected elsewhere, by a disturbance of the relation which subsists between it and the chymical or other products of the organ, and not with the spirit belonging to the organ. The more evident examples of the latter are furnished in the preparatory organs, to be spoken of hereafter.

§ 4. The instances of direct relation are some of them furnished by physiology, and others by disease. The former are exemplified in the cases where a *dependence* of the function of one part appears to exist upon that of another. Some obscurity and doubt must rest upon these examples; some of them may, however, be

enumerated as follows. In the organic system, the action of the heart ceases by the destruction of the spinal marrow; all the powers of motion existing elsewhere are destroyed in the same way: some secretions are modified or suspended by a division of nerves supplying the secreting organs; the function of the organs of respiration is made to cease in the same way, &c. In the animal system, the action of a voluntary muscle is destroyed by a similar division of nerves, or by compression or laceration of their centres. Sensation in all its seats acknowledges a similar dependence.

§ 5. The latter instances, viz. those illustrating dependence in disease (or preternatural condition), are exemplified in the cases denominated those of sympathy. These, also, are in some respects liable to doubts: they are enumerated as follows: a fractured bone disorders the action of the heart, quickens the pulse, &c.; the stomach becomes disordered from the same cause, there is loss of appetite, furred tongue, &c.; the brain is affected from the same cause, and delirium may occur; the secretion of the kidneys is scanty or almost suspended, and the urine is changed in other respects, &c. These consequences appear to indicate an extensive chain of dependence: thus, inflammation arises in the fractured limb, with other local peculiarities which need not be mentioned; the whole constitution *sympathises*, or the whole of the organic spirit in its several seats becomes affected by a communication with that which is locally changed; or, to pursue the instances, pain arises in the shoulder when the liver is influenced, or a testicle may swell from strictures in the urethra, &c. These examples are numerous and familiar, and need be no further particularized.

§ 6. It may be objected that these latter examples are not unequivocally illustrative of the direct relation, as, in the case of inflammation, the fluids may be changed by the altered condition of the spirit in one seat, and the influence thus mediately communicated to other parts. But this would be to lay an undue stress upon a mere possibility, which there is the less reason to do as the objection can scarcely be imagined to apply to some of the other examples, which for the sake of a more complete illustration I shall still further extend.

§ 7. If a considerable injury is inflicted upon one part of the spinal marrow, the functions of the whole (indeed of the whole body) cease. If one part of the brain be injured, the function of the whole are either modified or cease. I have seen also, in an experiment, the action of the heart immediately destroyed by passing a lancet through one ventricle. If a muscle be half divided in a transverse direction, the power of contraction in the uninjured portion will be either impaired or destroyed. The injuries of nerves also exhibit many curious connections of the same kind. All these instances are sufficient to prove a direct relation of some kind: the kind or mode of the relation remains to be investigated.

§ 8. The place of injury, or that which appears to give origin to the series, may be called the primary seat; that place, or those spheres, where the distant or contiguous effects of the injury are contemplated, may be called the secondary seat, which may also be the primary in relation to a further seat of affection, and so on to an undefined extent.

§ 9. In our doctrines of causation we have assigned only two modes of influence producing change, viz. by adding to or taking away from the properties which constitute the subject of the influence, or the subject of the change. When the function of uninjured parts of the brain cease (as they will) from an injury of the spinal marrow, what, according to the investigation just proposed, is the process of this consequence? The brain was in possession of certain faculties, which were manifested by their operation: the spinal marrow is injured, and those faculties of the brain cease, or reverse the order, and suppose the function of the spinal marrow to cease from an injury of the brain; this case is not so liable to objection, by reason that though an universal paralysis may have occurred in the system of voluntary motion, &c. yet the action of the heart may be but slightly interrupted. A change has taken place in a secondary seat: has it arisen from a communication of properties to it from the primary, or seat of the injury? or, is it that the natural functions of the secondary, was before dependent upon properties imparted to it from the primary, seat, which communication of properties ceasing in consequence of the injury, the dependent function of the secondary seat ceases from their privation? This question, which is in every respect a legitimate one, shakes some received doctrines of physiology to their foundation.

§ 10. There are many parallel cases where the question is also, though perhaps not equally, applicable. A nerve is intercepted and the functions of the inferior parts cease. Hence it is inferred that the inferior parts were in a sort of habitual receipt of properties or faculties from the superior parts. This inference is made upon an analogy which must not be universally admitted: it must not be admitted (unless it should be found to agree with a criterion which remains to be discovered), because in the instance of a nerve the properties of it might be, in a way before explained, related with the foreign agency. Not so with the blood in an artery, which is a specimen of the analogy: here the communication is merely cut off; but in a nerve the properties of inferior parts may be modified or destroyed by an influence *conferred*. I would ask, then, as the effects of injuries of this kind may happen in two ways, what known criterion have we by which to ascertain from such experiments the true relation between connected parts?

§ 11. This criterion can neither be deduced from succession nor from the existence or want of reciprocation; to exemplify, it may be said the destruction of the function of the *lower* portion of a nerve always succeeds to its division, while the superior portions

continue their functions unimpaired, though the inferior portions may be removed. Such, I say, may be the result of a relation between the injury and the properties of the inferior portion without giving occasion to infer from such facts that the inferior is continually deriving properties from the superior parts of nerves. But if the inference is questionable in this example, what shall we say of it in others? Without pushing this point any further at present, let us see the amount of that which is absolutely proved by these facts, which is simply this:

§ 12. That there subsists a relation between the properties of different seats; that, by an influence upon, or destruction of, those in one seat, those of another will either be modified or made to cease. If we would have unquestionable proofs of a perpetual communication among the vital properties (similar to that of the blood, which is perpetually passing from one set of vessels into another), we must derive them from some other source.

§ 13. Although I have objected to some inferences, as *necessarily true*, which have been made from the effects of the division of nerves, yet I would not be understood to deny their probability in general instances. I have mentioned that which might be urged as a refinement upon scepticism, merely to furnish an indication for an inquiry of the strictest possible kind. Meantime, in addition to the evidence which is afforded by the consequences of the division of nerves, we possess also that afforded by the general fact, that no insulated portion of an animal structure can live. Hence it may be presumed (but how fairly we shall presently examine) that the life of no part is perfect of itself, or that it is a specimen of independent life. If however this conclusion were granted, it would follow further that the life existing in one sphere is invariably dependent upon a supply of properties which it receives from some other, which, as will presently appear, is not agreeable with truth.

§ 14. But, it will be asked of this additional proof, whether the life that ceases in an insulated sphere may not be destroyed by an agency conferred by the means which separated this portion from the rest? To this I reply that the supposition is not in agreement with fact. If a muscle be cut transversely, half through the divided fibres both above and below will live while there is communication with living parts; but if the limb be amputated at the same point, then the life of the same identical fibres, which have sustained the very same operation, will become extinct, that is, a portion of structure will live while connected with the rest, under precisely that agency which would occasion its death when separated from its living connections.

§ 15. This last observation appears to give additional validity to the inference before said to be liable to some sceptical doubts. It is to be inquired what sort of criterion we possess, for distinguishing between changes produced by accession, and those arising from privation in general instances. The subject is full of

difficulties: much error and confusion have arisen from these difficulties, yet the source of perpetual blunders and of the greatest confusion has never in this instance been even suspected. It is my present business to indicate some points which belong to the topic.

§ 16. Perhaps it may be said that all the phenomena of life which can become the subjects of investigation are matters of inference; hence the great uncertainty which must attach to them, and the more especially as the few facts upon which the inferences are grounded are not those of every-day experience, so that their force and connexions are known but partially. In agencies of which the senses can take account, it is easy to discriminate between a phenomenon which results from a cause conferred and one taken away. I need only advert to the operations of chymistry: though here a great deal of the subtler business is matter of inference; and therefore this science is not certain to the full extent to which it is investigated, or to the extent for which it has obtained credit. To return to the inquiry respecting our criterion, &c.

§ 17. If the connection between two continuous parts may be separated, and each part preserve unchanged the properties which belonged to it, it may be inferred that the properties existing in each of these parts have no essential dependence upon those existing in the other.

§ 18. A primary, producing a secondary affection in a different seat, proves of itself only that the properties of the two seats are liable to communicate.

§ 19. In order to determine the mode of the secondary affection, it must first be ascertained what are the effects of a separation of the two continuous seats? If such a separation might be made, and each seat preserve unchanged the character and properties which before belonged to them, then it might be inferred that the secondary affection does not arise from the privation of properties naturally and regularly imparted to its seat, but that the secondary affection results from a foreign influence, conferred in consequence of the preternatural condition which the properties of the primary seat had assumed.

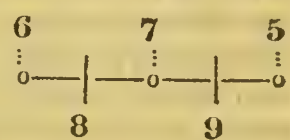
§ 20. If in consequence of the separation of connected parts the characteristic properties of one should be rendered extinct, the alternatives to be inferred are, either that the injury involved in the separation has produced the extinction of these properties by an influence conferred, or that their extinction happens in consequence of an habitual source of the properties in question being simply intercepted.

§ 21. In order to decide this matter in a way which is the least likely to mislead us, we must recur to our nearest analogies. In a general way, then, in consideration of these analogies, we are warranted to infer that a simple division of continuous parts does not operate to the destruction of properties independently maintained; one instance of this has been cited in the division of

muscular fibres: this is unequivocal in regard to the organic life, which we are now considering, and is borne out by a similar testimony in the animal department which we shall presently mention.

§ 22. But some *injuries* of connected parts, where there is no dependence, as on properties received, may destroy the health, or render extinct the living properties of a secondary seat. As an example of this law, a ligature on one or more of the brachial nerves may in a rabbit destroy the vitality of the foot, occasioning the sloughing of the skin, muscles, &c. below the place of injury; but the same nerves may be *divided* at the place where the ligature might have been applied, and the vitality of the skin, muscles, &c. of the foot and leg will continue. The former is a clear case of influence by communication, assumed in consequence of the *injury;* and not of influence by privation, because the *division* of the nerves, with the preservation of vitality in the inferior seats, proved that the vitality in these seats was independent of that superior seat, by a preternatural condition, of which the vitality of the former may be modified or destroyed.

§ 23. There appear to be cases in which parts may be naturally dependent by communication, and yet preserve an unimpaired condition under a separation; but these cases are equivocal, by reason that the continuity of vessels may perform the relative office otherwise imputed to spiritual continuity. Thus, to exemplify such a case, suppose such a defined spot of a nerve in an extremity as 7 communicating with 6 and 5. If the communication with 6 be cut off at the line 8, then the properties will be maintained at 7 by communicating with 5. If cut off by the line 9, the properties at 7 will be maintained by communicating with 6; and that the dependence of the properties at 7 is by communicating either with 5 or 6, or with both, is proved by the fact that if the two sections 8 and 9 are made at the same time, and the portion of nerve 7 thus separated totally from its connections, it will die and its structure fall to decay.



§ 24. These laws apply to, and are deduced in conformity with the modes of change in general instances. They are also by their illustration shewn to belong to animal bodies. It remains to investigate the agents concerned in the dependence spoken of; and this must be done by a retrospect of some former doctrines, connecting them closely with the business of this section.

§ 25. It cannot be proved that the life or the organic spirit of any seat is essentially dependent upon that formed or existing elsewhere: for though it is admitted that a portion of a structure when separated from the rest cannot live, yet there is in such portion not only a separation from a contiguous living principle, but its sources of blood are also cut off. It is shewn in a former article that the terms of the maintenance of life are comprised in the existence of an organic spirit properly identified, and in the sub-

jection of arterial blood to the influence of this spirit: from the former, the latter assimilates itself. The truth of this account must be rested on the proofs cited in the chapter on the Condition of the Spirit.

§ 26. Now if life is maintained by a reciprocation between the properties of blood and the organic spirit in every sphere, in the way of assimilation described, it follows that the existence of the organic spirit is in no sphere dependent upon an habitual receipt of properties from another seat, for if life were diffused to all seats as from a centre, there would be no need of the presence of blood to maintain the life of respective seats. But the processes are incompatible upon the supposition even that the spirit in distant seats is identified by certain auxiliary properties derived from a centre; for that which is maintained by assimilation being once formed ,depends upon its pabulum (the blood), and is independent of a source, supposing it to have been originally derived from one.

§ 27. If it be said that a limb will not preserve its life though arterial blood be injected into it, I reply, that it is very certain that it will not after the principle of life has become extinct: but I am inclined to think that if a transfusion of arterial blood into the amputated limb could be made before its life had become *extinct*, from stoppage of the circulation, or conversion of arterial into venous blood, its life would be preserved in a ratio to the truth of the imitation. We have no direct fact upon this point, and the experiment, though difficult, would require attention to many more particulars than are here suggested. We find, however, that by oxygenating the blood (or inflating the lungs) after decapitation, the organic life may for a considerable time be maintained, notwithstanding the separation of that which was considered a source of spiritual properties: thus far the analogy; but as this fact, to the extent to which it is assumed, is undecided, we must rest our proofs upon the doctrines and connections just referred to. We may, if we please, multiply our analogies, tending to the same conclusion; we may advert to some animals, among whom, as is well known, a detached portion will not only live, but originate growths. This must happen from some laws of conversion between their life and their structures which are not common to the Mammalia, which we profess to be considering.

§ 28. The phenomena of the ovum not only agree with, but help to confirm this supposed independence of the existence of the organic spirit of one sphere of that existing in any other. The development of the growths is preceded by an unfolding, or a series of changes in the combinations of the integral properties of life. The forms of life separate and assimilate: their first separation is no weak proof of their independence respectively; it proves, and the results of the several combinations prove, a difference which precludes the supposition of a common source. Thus, then, the properties of the spirit in the ovum, having relations among themselves, afterwards preserve certain relations: the respective

combinations of properties constituting the life of the respective seats are capable of assimilating and maintaining themselves by their relation with the blood, independently of other spiritual properties.

§ 29. But although an organic spirit may exist and assimilate independently, yet the spirit in every sphere cannot always be said to be perfect in that sphere; that is, although, independently of the spirit of any other sphere, an organic life, according to our definition, would be maintained, yet the attributes of this life may be modified or suspended by an interruption which relates only to spiritual communication, and which is no interruption to the blood. Some powers of muscles (which will hereafter be appropriately designated) we know to depend upon a communication with the brain; yet the organic life of those muscles may be preserved under a total division of the nerves. So the secretion of the stomach is said to be prevented by a division of the eighth pair of nerves, &c. But in these cases, and especially in the latter, it is not to be inferred that the life, or even the power of secretion, is wholly dependent upon a nervous centre; for we find that where there is already the predisposition, the effect of it does not take place for want of a mere stimulus,* and this might be furnished by a hundred things indifferently. As when the mouth is dry, saliva might be made to flow by sugar, salt, tobacco, by chewing a stick, &c. Hence it has been, absurdly perhaps, inferred, that agents, capable of re-producing a secretion suspended in consequence of a division of nerves, have been the full and total identity of the cause of the secretion, as electricity, &c. We find, however, from these views, that the subject is liable to be considered in the modes before proposed, viz. influence of spiritual properties of seats by privation and by communication. It remains that we should sum up the criteria deduced from some of the illustrations of the present article by which the inquiry is to be conducted.

1. A simple division of a structure may destroy the life of an inferior part of the same structure; but if a connection with living structures is preserved by blood-vessels, this rarely happens except by processes of disease.

2. When a secondary, happens in consequence of a primary, injury or affection, if it is ascertained that the life of the secondary seat may preserve its identity, &c. when separated from the primary, it is to be inferred that there is no dependence between them, and

* The word "stimulus" is employed to denote a cause capable of producing certain effects upon a certain predisposition, by properties common to it, and many other substances which are made to appear different by their combinations; thus, brandy, æther, laudanum, blisters, spurs, whips, &c. are all stimuli, that is, these substances, though different, have, so far as the effect is common, a property in common which produces it. This matter has been explained in the chapter on Causation, where, treating on the various associations to which similar properties are liable, it is also explained, that notwithstanding these different associations, the properties in question may produce their proper effects upon their other relations, unless the associated properties are so related also as to counteract this end.

consequently *that the secondary change must happen by communication, and not by privation of properties.*

3. As the cases just referred to are among the commonest we are called upon to witness, it is to be inferred that the communion between parts may subsist without dependence, so that an injury in one seat may destroy in another, by the derangement imparted from the first to the second: thus a ligature on a superior part of a nerve may produce a sloughing of the inferior, while no such effect will follow a simple division. Hence *injuries* are no proofs of dependence, although they have been confounded with others as such.

4. But the results of simple division in general will indicate a dependence, because it is not the common effect of division to impair the properties of remote parts by *communication of influence.* Not but this may happen, and the cases have been adverted to in which it does happen; but, weighing the larger portion of our experience against the smaller, we are, according to the right of inference, justified in thinking, when certain properties, making its function in an inferior part, as of a nerve, cease in consequence of a simple division, that then the inferior part is dependent upon the superior for those properties. But of what kind, or how far they may be possessed in common by other substances, entitling them merely to the appellation of stimuli, is neither discovered nor sought for. A determined scepticism may oppose both the above conclusions and the general sense of mankind, upon the same cases; it may urge, that under the change which a portion of a nerve undergoes by an injury, &c. this local state of the nerve may open a relation with the brain, by which the latter acquires or derives properties from the former, thus identifying or constituting pain, and other phenomena of such injuries, *by the properties of a nerve, which remain after some are taken away.*

5. As the mere existence of organic life is not directly dependent upon any other seat than that in which it assimilates; so if the organic life is modified or ceases in a secondary seat, as a consequence of a primary injury, it is by *a communication of properties through connected spheres.*

SECTION II.

ON THE PREPARATORY ORGANS.

CHAP. I.—*General Relations of Preparatory Organs.*

§ 1. BY the preparatory organs are meant those whose business it is to make blood: they are well known as consisting of the abdominal viscera and the lungs. But of the share taken by each in this process we are but indifferently informed. I shall, in their proper place, offer a few indications upon them respectively.

§ 2. By the function of the stomach, food is made chyle: this is the effect of the function; but of the function itself, does it reside wholly, or partially, in the stomach? if partially, on what other seats has it a dependence? and what is that in which its own principle is deficient? These questions certainly cannot be all answered at once, and some of them perhaps not at all.

§ 3. The life of perhaps every part, but certainly of most parts, is of two kinds, viz. regular or independent, and occasional or dependent. That which I call regular is made up of those properties which, separated originally from the entire spirit of the ovum, and becoming diffused according to the laws of properties (elaborately spoken of in the chapters on the Ovum), develop, or form, or permanently influence, those which become their respective seats. The occasional life is that to which properties are communicated from another seat, modifying the regular life. The regular life is capable of maintaining itself by assimilation, and of preserving also the existence of the textures which it before formed. The occasional is not an assimilating life, because the properties which make it occasional endure no longer than a communication is preserved with their source.

§ 4. These two spirits just mentioned (*cæteris paribus*) act when they are present; the regular is always present, and always main-

tains its identity, and preserves the textures, &c. The occasional is communicated, and effects its purpose, and ceases in the remote organ, unless the communication is made in some degree permanent to fulfil the objects of such a duration.

§ 5. The regular assimilating spirit requires only to be supplied with arterial blood. This is supplied to the fœtus by a preparation which takes place in foreign organs. Hence the fœtus in all its progressive growth, except in the latter periods, possesses in its several seats only the assimilating life; which, requiring only to be supplied with blood, in order to be maintained, does not stand in need of the occasional life, and exhibits none but the functions connected with its assimilation: *its life is progressive before functions exist to aid its development;* the only condition is the supply of arterial blood, which it obtains from a foreign source. This source being prevented, as it is in the state of independent life, it is necessary that an occasional life should be established, producing specific functions, the principal object of which, in regard to the organic life, is to make that blood for the animal which was before made for him.

§ 6. Although, then, the tendency of the spirit of the ovum is to a separation of the properties which compose it, to a diffusion in respective spheres, yet the connection of a whole is preserved; and while the several combinations of properties left to themselves are capable of habitual or regular effects, yet they are liable to be influenced by changes in their distant relations. These changes may be of an orderly or of an accidental kind, we have examples of both; but the functions which arise after the birth of the animal, and which are necessary to his preservation, belong to the first.

§ 7. Life, in the fœtal stages, operates independently of that existing in other seats. The alternatives after birth are, that this independence should be continued, and the animal die from defect of the blood which was before prepared for it; or that changes should result, in conformity with a new condition, which changes are in agreement with relations before not called into action, and which afterwards tend to perpetuate the existence of the animal. Thus the dependent functions begin by change of relations, and the dependence is afterwards kept up by the operation of the same causes of change. These changes may arise in part or wholly, spontaneously, during the last stages of fœtal growth, or they may be excited in part by foreign causes, incident to the state of independent life.

§ 8. It is ascertained that the mechanical powers of respiration are dependent upon the brain or cervical medulla. These powers in the fœtus are not possessed because the relation by which they are obtained is not then established. But how, it may be asked, is it proved that the power, though not exercised, does not reside with the respiratory muscles? If the power of mechanical respiration does at that time exist in these muscles, it must be obtained from the brain, since this power ceases when the communication with the

brain is intercepted. If this is allowed, it follows, since the power is dependent upon the brain, that a relation subsists between this viscus and the respiratory organs, by which the latter are in the habitual receipt of properties by which they are animated from the former. Granting this, the distinction of the assimilating and independent spiritual properties is not invalidated. But whether any such relation exists, we must still further examine.

§ 9. It may be objected against the existence of such a relation, that it is contrary to that order of processes which alone appears consistent with facts. The power which performs mechanical respiration is one which is perpetually expended; it is proved therefore by this circumstance, as well as by the fact that the brain furnishes it no longer than this viscus is supplied by arterial blood, that this power is renewed by assimilation. The radicle of the power in question, in a way before explained, existed in the ovum; and the seat of this precise spiritual combination was, as must be allowed, fixed, like that of every other spiritual combination, by causes and relations which obtained during the periods of formation. The tendency of the relations which *fixed* the seat of a spirit is to preserve it in that seat: if its separation from that seat takes place, it will not be disputed, but causes must operate to produce such a separation which did not operate when its seat was determined. Without giving this argument an undue force, we may allow that it is consistent with general analogy: according then to it, the spiritual combinations which separate from the ovum and take up their respective spheres, although connected as the textures are, have an existence independent of the rest, and produce their own effects: how does the sphere of one spirit interfere with that of another, unless the relations which presided at the time of their settlement are disturbed by change? This is the most perfect condition of unmixed organic life, and it is exhibited by vegetables and by some animals which are the nearest to vegetables; and which, possessing no other than the organic life, must be regarded as the models upon which our definition of it is founded.

§ 10. But, independent of the support of general analogy, we shall find that the same opinion, viz. that the relations of properties by which they communicate, for the purposes of functions, are not all of them established during fœtal existence, or until the changes incident to independent life have taken place; we shall find that this is at least consistent with, if not confirmed by, the more particular analogies and examples.

§ 11. We will begin with deglutition: the muscles concerned in this process, and those which operate in connection with them for the purpose of obtaining food, during fœtal life, are in a state of rest; they first act by volition, produced by appetite; the voluntary power of these muscles is dependent upon their communication with the brain. As this appetite and consequent volition did not obtain during fœtal life, some change must have influenced relations, to occasion them; this change is involved in the processes of inde-

pendent life, which the animal at the first periods of nutrition from externals has begun to assume. This then is one illustration of our argument: muscles of deglutition, &c. possessing their own properties in utero and at rest; a volition originates from the brain, the assimilating life of the muscles in question receives properties by communication; to trace this series—

§ 12. The function of digestion, not manifested during fœtal development, is formed by the life which afterwards preserves it; this being made up of properties settled by the relations between spiritual properties, and their subsequent material of nutrition, in the ovum, food enters the stomach by the preceding acts of deglutition, &c.; the properties of the stomach have a relation with food and sustain corresponding change; properties of the stomach connected and related with those of the brain; change in the properties of the stomach, producing correspondent change in those of the brain: the end of this relation is, that properties, quitting their native sphere, pass and re-pass between the stomach and the brain, producing their specific effects, that is, complying with the relations of the properties engaged, and contribute to accomplish the phenomena of digestion. Whether this is a true account of this particular example, or a mere illustration of a mode, we shall hereafter consider.

§ 13. To recur to the instance of change preceding communication before mentioned, which is exemplified in respiration. The organs in the fœtal state, quiescent and independent; their independence first disturbed by a cause of change; that cause, the admission of air into the lungs; properties of the respiratory organs affected in consequence, according to their relation with air, these properties related with the brain or cervical medulla; properties pass and re-pass from the organs of respiration to the brain, a perpetual re-agency occurs, settled by predisposition, or the pre-existent relations of properties; the end, the establishment of the function of respiration.

§ 14. To anticipate a little our subject, we may borrow an illustration still more conspicuous from the system of animal muscularity which is subservient to loco-motion. The muscles of the leg (for the sake of precision) have their assimilating life, which first formed and is afterwards capable of preserving them; the nerves which supply them are formed and preserved in the same manner; this is their organic existence, and thus far they are independent of other seats; but they have a function capable of originating loco-motion, and for this they are dependent upon a nervous centre. But the exercise of this function arises not from a natural communication of properties from the nervous centre, but from a *disturbance* of the natural disposition (meaning that disposition which occurs during fœtal growth), from a change of the properties of the nervous centre, which results from the influence of causes to which in its new condition it is exposed. To exemplify still further the origin of a relation by *disturbance* of the properties of a seat,

§ 15. We will suppose a time when the animal system is at rest, possessed and actuated only by the organic life: the senses also may not just then be taking cognizance of the objects which surround them; but the mind might be associating, or engaged on past impressions, as in a reverie: on a sudden the report of a pistol is *heard*, the man starts up; what is this process? Properties constituting the sense of hearing are *changed*, modified, or affected, according to their relation with the report of the pistol. The brain, before independent of the properties of the auditory sense, is now affected by them; that is, a relation is opened or exhibited which is dependent upon the change (or disturbance) produced in one sphere of connected properties. To proceed: the muscles of the leg, before quiescent, and their state independent of the brain, now assume actions corresponding with the relations of their properties with the present, the changed, condition of the brain. The man starts on his feet, rushes into an adjoining room, and, by a similar series to that just described, engages in all the complicated re-agencies of properties incident perhaps to a contest for life. These illustrations are sufficiently numerous: to subjoin then the principle, the proofs of which are before stated, and these examples are not designed as proofs, but are introduced chiefly for the purpose of illustration, and in order to shew their conformity.

§ 16. The organic life is every where an assemblage or combination of properties, making an assimilating principle, the identity of which is the result, or settlement of that progressive causation which takes place among the vital properties of the ovum, and is matured in the periods of uterine growth. In almost every seat, the properties of the organic life are different and peculiar; their differences may arise from the relations engaged in the progressive causation just spoken of, and these differences, respecting only the assimilating principle, are independent of any other seat; or difference, or peculiarity, of the spirit in any seat, may arise from communications with organic properties assimilated in another seat. Hence the organic properties (or life) of seats, *may be classed under these three divisions* viz. the *regular assimilating*, the *regular dependent*, and the *occasional dependent properties*. The first assumed their place in the processes of the development of the ovum, and they maintain themselves in their place by assimilating their own identity from arterial blood; the second do not originate in the place where their action is observed, and they are not maintained in this place by assimilation, because they are dependent upon a source; but they originate in some other sphere, with which that where their action might be observed is naturally and spontaneously related; the third, or occasional dependent life, is so produced that by an influence, occasioning change in the properties of one seat, the distant related ones may be also changed, and re-act upon the properties of the seat where the affection or *impression* (if it is more intelligible) commenced. The first is displayed in all the stages of fœtal growth; of the second there are many examples in the latter stages of fœtal

growth; the third is chiefly produced by the influence of the externals to which the condition of post-fœtal or independent life is exposed.

§ 17. How far properties may communicate during all the periods of fœtal growth, for the purposes of that progressive causation which is proved by the development and conversions of the structures, cannot be affirmed. Properties may, during these processes, assume their spheres by abstraction or separation from that nucleus in which they were first combined; or they may be identified in their respective spheres by subsequent communications. These are relations not easily analyzed: but presuming that an intercourse of properties does not take place without an object or a result, it may be conjectured that the communications between vital properties which subserve to the establishment of functions and the maintenance of independent life, either commence when the maternal alliances cease, or else are preparatory to this period. The animal being then exposed to the operation of new causes, these causes produce other changes in his spiritual properties, which changes are again influential upon connected properties. The final result of this disturbance of primordial relations in the department which we are considering, is to produce that blood which was before supplied by the mother: this is the physical effect of the causes concerned; and the organs by which this end is accomplished are called, in reference to the blood which they prepare for purposes of life, preparatory organs, concerning which, respectively, some indications for inquiry are now to be suggested.

CHAP. II.—*The Stomach.*

§ 1. THE object of investigating the function of this viscus is to understand by what agents, and according to what laws its purposes are accomplished. The most familiar and obvious use of the stomach is the conversion of food into chyme.

§ 2. We are taught by our doctrines of causation, that every change is produced by something added, or by something taken away; accordingly an investigation, for the purpose of ascertaining in what the above change consists, must be of the analytical kind.

§ 3. There is no such thing as a perfect or complete analysis. To follow distantly the design of a perfect analysis in the present instance would require that we should be so far informed of the constituents of food, as to be enabled, by a comparison of food with chyme, to say what the former has lost or what acquired by its conversion into the latter. So perfect a knowledge is hopeless: we have not even ascertained the relation of the constituents of food with each other, so as to be enabled to say, how much in a conversion is to be attributed to a change in the combination of its own constituents, and how much to foreign ones.

§ 4. A few of the chymical differences might be enumerated: is is then to be asked, what are the properties, or where are the properties which produced these changes, seeing that nothing like a similar conversion will result from an imitative employment of the same alleged agents? Let us, however, make a more precise indication upon this matter: he who profits by it must be a shrewd inquirer.

§ 5. The relation subsisting between food and the function of the stomach is to be considered (conformably with the general division before expressed).

1st, According to the *mechanical* relation subsisting between food and the structure of the stomach.

2nd, According to the relations between the *chymical* constituents of food and those supplied by the stomach.

3rd, According to the relations between the *vital properties* of the stomach and the properties of the same kind in food: thus far they may be considered separately. They are also to be considered reciprocally, that is, as the stomach acts upon food, and the con-

verse. They are also to be considered as regular and occasional. Lastly, their mutual or conjoint agencies are to be considered according to the following order.

1. Mechanical Relation:

1st, As mechanical phenomena in food are directly produced by the mechanical agency of the stomach.

2nd, As mechanical changes in food are produced by relations of the chymical agents furnished by the stomach, with those of the same kind in food, with which the mechanical are in alliance.

3rd, As mechanical phenomena in food are produced directly by the agency of vital properties of the stomach, or as mechanical phenomena in food are produced by vital properties of the stomach through the medium of the chymicals and their relation with the mechanicals. It is also a matter to be decided, whether this latter (the mediate agency) is not invariable, or in other words whether the direct ever takes place.

2. Chymical Relation.

1st, As chymical changes in food are produced by the chymical matters supplied by the stomach. The changes attributable to this agency are to be specified.

2nd, As chymical changes in food (if any) are produced by mechanical action of the stomach (this action may perhaps contribute towards the process of digestion in birds, by a mechanical mixture of the chymicals of the stomach with those of the food). But the effect of such a relation, if any take place in the human stomach, can be scarcely worth inquiring after.

3rd, As chymical changes in food are produced by a relation subsisting between its constituents and the vital properties of the stomach, these changes are to be inquired after and specified.

3. Spiritual Relation.

§ 6. To propose an investigation of the precise relations between vital properties, pre-suppose at least that these properties are known. The investigation would require that the varieties of vital properties contained in food, as well as those belonging to the stomach, should be specified. The question, whether the effects result from privation or addition of properties, in agreement with our doctrines of causation, will require in every topic of these relations to be determined. The relations between individual properties on either side can be known only by distinct experimental combinations: and the integral relation of the spiritual properties belonging to the stomach and those of food, can be known only by a separation of these properties from their alliances, and by rendering them objects of the senses, which we may venture to say will not be done until a method shall be discovered for performing impossibilities. Thus much, however, by way of indicating those points, the possession of which would leave us as well instructed respecting one great operation of the animal economy, as we are of the relation which the parts bear with each other in the simplest piece of machinery. We must be content for the present with a looser method, which aspires only to

furnish a few hints upon the objects of the investigation, or to exhibit another example of the general conformity and subordination which we have hitherto traced.

§ 7. If food is put into the stomach of an animal some hours after death it will not be reduced to chyme. The stomach may contain those secretions which are formed preparatory to a meal, and which furnish the chymicals produced by the stomach: ~~our~~ regard due also may be had to temperature; yet this food will not be digested *as in the living stomach*, but, if of the animal kind, will follow the fate of the animal structures, it will be decomposed by putrefaction.

§ 8. As food will not be digested unless life is present, it is necessary to infer that life is essential to digestion.

§ 9. But it is not a mere principle of life of any sort that will accomplish this end. How, it will be asked, is this ascertained? A digestible substance may be well impregnated with gastric secretion, and in this state sewed under the skin of an animal, by which it will be as effectually surrounded by a principle of life as in the stomach; yet, without making the experiment, it may be almost affirmed that this substance will not be reduced to chyme. That it should is contrary to analogy; for, in the experiments and operations of grafting animal substances, we find that the foreign ones are never made chyme, but that they are dissolved by putrefaction, except in cases where an union takes place between them.

§ 10. The organic spirit of the stomach, then, is one which has *peculiar properties*, in addition to those (many times specified) which are sufficient to characterize a vital principle. The relation, or a relation, of these properties with food is to assist in its digestion.

§ 11. The secretions of the stomach furnishing on the part of the animal, as has been said, the chymicals which are related with food, it is supposed, contribute towards digestion; but their share in this process is not ascertained, although experiments have been instituted with something like this view.

§ 12. The general history of these secretions, made up of constituents, which chymistry to a certain extent can analyze, is this: Tubes, variously connected, continuous with the blood-vessels, called their secerning extremities, open into the stomach. These tubes separate, and then excrete into the stomach peculiar fluids. The fluids which it is their function to form, cannot be produced by any known hydraulic imitation; they are never known to be produced but whilst life is present. It is hence to be inferred, that blood supplies a material, certain parts of which are so related with the vital properties, inhering with a certain order of vessels, that the end of their relation is to produce the secretions in question.

§ 13. Thus the participation of chymical agents in the process of digestion may be said to be the effect of a previous operation of certain properties of life. The history of this life is to be a little further traced.

§ 14. It has been before said that our means of analysis are too imperfect to admit a specification of the share which the agents

concerned, respectively, have in the process we are considering. But the final purpose of their concurreuce is sufficiently clear.

§ 15. The substances which support life, when submitted to the functions of the preparatory organs, not only will not support, but actually destroy it, if introduced into the circulation in their crude state. Hence it is obvious that the final purpose of the function of the stomach is to produce in food a change which constitutes the second stage (mastication and deglutition comprising the first) of preparation, for such a relation with the other seats of life and organization as will concur towards their support.

§ 16. The life of the stomach has been divided into the regular assimilating, and the dependent functionary. The former is that properly belonging to the texture, and is independent of all other seats, being dependent only upon the properties of arterial blood: the latter is so far dependent upon another seat, that a division (which we have admitted as a test of influence by privation) of the nerves which supply the stomach will impair, or perhaps incapacitate the organ for its digestive function.

§ 17. The laws which govern the functionary life are perhaps in many circumstances irregular. In the instances quoted from the animal system, we have observed that the influence communicated to a distant seat is traceable to a foreign cause, which disturbs the natural state of quiescence, and in some measure of independence. Thus the muscles of the legs may act in consequence of an operation upon the auditory or optic nerves, &c. In other words, an influence is communicated to the brain, of the occasional sort, which if the muscles of the legs before possessed, independently of the brain, they would move, whether a train of actions were laid or not, by an operation upon the auditory or optic nerves.

§ 18. But, although communication of influence making function is clearly shewn to take place in many instances, as the result of a relation which is manifested under preternatural circumstances; as in the examples just quoted, by foreign excitation; yet it does not follow but communications for the same end, viz. that of perfecting functions, may be perpetually taking place under the operations of causes, which are so far natural, that they may even be possessed by the fœtus. Such a perpetual communication may take place without invalidating our distinction of the assimilating and dependent or occasional life; and whether the communication does take place in the subject of our present consideration, we are to examine. The question relates to the organic system.

§ 19. The proper secretion of the stomach is formed when this organ is under no foreign excitement by food, or, in other words, when it is empty. If the properties necessary to the secretion do not wholly belong to the stomach, but are in part derived from another seat, then this example furnishes a proof of a spontaneous diffusion of vital properties, and an alliance of them with the inherent life of the seat to which they are conveyed, for the purpose of establishing a function. It has been assumed, upon the credit of

experiments which are not wholly unobjectionable, that the secretion of the stomach is no longer formed when its communication with the brain is intercepted. Hence, if the secretion cannot be produced by the regular and assimilating life of the stomach singly, and if properties from the brain singly (as may be proved) cannot produce the secretion, it follows that both are necessary to this result; and if the result takes place, as it is said and known to do, when the organs are under no preternatural influence, it follows that the properties by which the function is constituted unite for this end, in conformity with a natural and habitual relation. It is probable that, in the progress of experiment, many instances of spontaneous habitual diffusion of properties from one seat allying themselves with those of another, for the objects of a function, will be discovered. It is probable also, that instances of the same kind might with truth be quoted from the animal system, as the possession of a faculty of sensation, which is manifested in all sentient points and derived from the brain, &c. But the instance already mentioned is sufficient to sanction an indication. In the mean time it is not proposed as the proof (any further than the fact asserted in the experiment may be admitted) of a spontaneous disturbance of the assimilating spirits of independent spheres. All that I would insist upon is the probability that the vital properties of one seat pass spontaneously to another, for the purpose of perfecting a function; and that they are sometimes derived in the secondary seat by the presence of foreign agents, which have a primary operation upon the properties of this seat. Of the latter, or occasional properties, we have spoken fully: of the former it is necessary still further to inquire, keeping in view as much as possible a line of investigation which is applicable to both.

§ 20. Now if it shall be confirmed by the increase of facts, as it is more than indicated by those above mentioned, that spiritual properties, which live in one seat by assimilation, pass from thence to another; it is to be inquired why they leave their original seat: and if they do not assimilate with the vital properties with which they enter into alliance (as it is plain they do not, because the function would then be independent of a source), it is to be asked, what is the mode of this union?

§ 21. Before it can be asserted why properties leave the seat in which they are assimilated, it seems proper that we should understand what becomes of the properties which appear to be unremittingly consumed? This is not an easy speculation, nor is it perhaps likely to be a very satisfactory one. However, difficult as it is, and although it is likely to prove unsatisfactory, the question belongs rather to the subject of death than that of life; and the consideration must be deferred till we speak of that subject.

§ 22. Thus much for the present may be observed, viz. that we do not find it indicated by the most distant connexion with our experience, that the properties which assimilate in one seat

universally pass to another; or, in other words, that they do not expire, as we must say, for want of a better word, in the seat in which they assimilate and live. Thus we have no reason to suppose that the function of any seat is influenced by the properties of that life which assimilates in the muscles of the foot, the skin of the forehead, in the os calcis, the olecranon, or the alæ of the nose, &c.

§ 23. If then, as it appears from this view, it is not an universal or even a general tendency in the properties of the organic spirit to pass from one seat to another (under natural circumstances), it is to be asked, why they do so in those few instances in which such a communication has been reasonably supposed? We cannot reply to this question: a real answer to it would comprise, 1st, a specification of the properties which pass (for example) from the brain to the stomach; and, 2nd, a citation of the properties with which the latter are related, and by which their migration from one seat to another is determined. This necessity is founded upon principles of causation already sufficiently explained.

§ 24. Here then again we are brought to a recollection of that which we want for a satisfactory information on subtilties which we aspire to understand. The deficiency I allude to is an additional sense, which would enable us to *know* properties, whose existence and laws we can now only infer, from particular analogies, or in conformity with general principles.

§ 25. Hence we cannot pretend to say *what causes* sometimes determine vital properties to leave their native sphere, and sometimes not. We can merely remark, that the vital properties of respective spheres are of various kinds; that various relations obtain among them; and that the phenomenon in question is one among the results of particular relations, which we must be content to enumerate, and that imperfectly.

§ 26. Concerning the mode of the union of properties which do not assimilate, to understand this process requires that we should be informed what becomes of the properties which do assimilate; or what is meant by their being *consumed.* This consideration we have said is to be deferred to the subject of death.

§ 27. But, in order to make our present question dependent only upon the result of that inquiry, it is to be observed, 1st, that the properties communicated modify only the life of the seat which receives them; and,

2nd, That they endure no longer than the communication with their source is preserved; and that therefore they, uniting with the assimilating life (when their communication is unremitting) as fast as it is formed, follow the fate of that life, or they expire; a process which we shall hereafter consider.

§ 28. Although it is rendered probable that some part of the organic function of the stomach is dependent upon the connection of this seat with the brain, yet it has not been attempted to ascertain how much. The experiments before alluded to refer

principally to the secretion of the stomach. Whether the digestive faculty depends upon communication with the brain, any further than the secretions of the stomach are necessary to digestion, remains to be determined.

§ 29. It is necessary further to inquire what other relations the stomach has with contiguous or distant parts. It is to be examined whether its function is in any way dependent upon the the liver, the spleen, the pancreas, &c. In this examination the division of the living fabric is to be observed. Of each severally it is to be asked, does the stomach obtain *vital* properties from the liver, the spleen, the pancreas, &c.? or has it with either a chymical, a mechanical, or a mixed relation?

§ 30. A perfect physiology of the stomach would instruct us of its relations as an agent, with respect to other organs, as well as concerning its own dependences.

§ 31. It has been indicated in the beginning of this article that in this way it is related with the brain. It has been remarked that the function of digestion is neither required nor manifested during fœtal life; that it takes place afterwards under circumstances (those of ingestion) in which the primary operation of an occasional cause must be upon the stomach and its properties. We have therefore to decide whether the stomach derives properties from the brain directly necessary to digestion, of an habitual or occasional kind; whether such an habitual communication takes place as that which has been almost proved with regard to the cerebral properties which concur in gastric secretion; or whether the function, being occasional, the brain furnishes properties for the purpose of digestion in consequence only of an operation of properties of the stomach upon those of the brain, the series of which might be expressed in this order, 1st, inherent properties of the stomach, produced by its assimilating life, affected by the presence of food; 2nd, properties of the brain, affected by relation with those of the stomach; 3rd, the result of this latter affection, a re-action of properties of the brain upon those of the stomach, contributing towards the process of digestion. This point cannot at present be decided, because we stand in need of facts to prove even that the digestive function is dependent upon the brain.

§ 32. But we are not without examples that a series of operations of the above kind does occur in other cases, where the occasional relation is exhibited. Thus a substance violently emetic produces vomiting so speedily as to preclude the supposition of its having reached the brain by the tedious course of absorption: properties either of this substance, or properties of the stomach modified by those of this substance, are propagated to the brain; a re-agency of the properties of the brain occurs, the secretions of the stomach, which are traced to a dependence upon the brain, are increased or modified, or both; the sensations of the stomach are also produced, and, finally, vomiting happens, by a participation in the disturbance on the part of the diaphragm and abdominal

muscles, which participation also is dependent upon the integrity of the nerves which supply these seats.

§ 33. Hence we perceive that the stomach is liable (agreeably with a general division) to the operation of three sets of properties; or is to be considered in respect of them, viz. the assimilating, the spontaneous communicating (or the habitual), and the occasional, or excited, communicating, properties. The first is distinguished by its having no dependence, except upon arterial blood; the second is inferred from the necessity which exists (for the purpose of certain phenomena resulting from its function) of a communication with another seat, and from the habitual or regular occurrence of the phenomena dependent upon this communication, when their seat is under no preternatural influence. The inference of the third must always be dubious: for, although the phenomena (as, for example, the digestion of food) are of an occasional kind, and never take place but under the presence of foreign substances, yet it does not follow, because the subject of the operation of a power is sometimes present and sometimes absent, that therefore the power itself is not always present. Yet this seems the only criterion: and if it be allowed to furnish evidence of any kind, it must be rated (in this example at least) at that which is weakly presumptive.

§ 34. There are many other instances of affection and re-agency which would illustrate our present topic, but they are well known, at least the facts are well known: they are enumerated under the head of sympathy, and belong less to physiology than to disease. My business is not to detail particulars, but to seek after and arrange those facts only which are important because they subserve to the establishment of *principles*. It is here sufficient to advert to the class of facts; merely observing, that affection might commence in any part of a related circle; that the order might proceed irregularly; and that the complication is difficult to be traced, because the natural order of affection, if any, may be inverted, and if no natural one existed, the unnatural is not at once recognized. But, granting the order of the affection of seats to be made out, there is still the most difficult part of the process to be analyzed, viz. the share in effects to be assigned respectively to vital, chymical, and mechanical, means; the agencies of which are rendered still more complex by their being liable to be considered, 1st, as results by addition and by privation; and, 2nd, according to the two modes of operation between them, viz. the direct and the mediate, of which we shall say more hereafter.

§ 35. There remains then, in viewing the stomach as an agent with respect to other seats, to inquire with what other seats it may be in this manner related: considering first the contiguous ones, as the spleen, liver, pancreas, intestines, &c.; and then those remote, if any. This examination, proposed rather in conformity with a systematic design than with any expectation of useful results, belongs to the *detail* of physiology, and not to the indication of its topics.

CHAP. III.—*The Intestines.*

§ 1. THE perceptible changes which food undergoes in these organs need not be enumerated. It is designed only to point out briefly the objects of investigating their function; and to exhibit their relations as a part of those general ones, making a system, to which they belong.

§ 2. It is the business of analysis to specify in what consists the difference between chyle and chyme. The changes which food sustains in its conversion into chyme are supposed to some extent to have been ascertained. A similar investigation belongs to every portion of the intestinal canal, the effect of the function of which is to produce new changes. Thus, it is to be asked severally of the chymical changes sustained by that which was originally food, in the duodenum, the jejunum, the ileum, the cecum, the colon, the rectum; and perhaps the same question may apply to the several parts of each.

§ 3. The chymical differences assigned, as they may be to some extent (the mechanical scarcely furnishing a topic of inquiry), it is the further business of analysis to specify the *vital* changes which are also produced in the same seats.

§ 4. The spiritual changes are in truth the principal objects of the several functions: for the final purpose of every stage of the preparation which food sustains is that it may become a material, the elementary life of which may be so related with the diffused formal, that the former may be capable of supporting the latter, and of contributing towards those phenomena of the structures which are connected with, or dependent upon, spiritual assimilation.

§ 5. I say then that it is the business of analysis, no less to settle these spiritual changes than to remark the grosser chymical differences; which latter will never be in any great degree explanatory of an animal process. But to specify these subtile changes would require that other sense, of which we have before regretted the want. Since then in this case, as in that of the stomach, we can only particularize that which we desire, rather than that which we are at present qualified to attain, we must be content with inquiring more generally and distantly into these processes.

§ 6. The intestinal material of nutrition is mixed with the secretions of the structure, and with those of adjoining glands. The chymical differences (or at least some of them) produced on

chyme by a mixture with the fluids added in the duodenum, may be known by synthesis, that is, by mixing chyme with the biliary, pancreatic, and mucous secretions, contributed by this part. This may be done in the laboratory. The artificial product may then be compared with the natural: some differences may be found to depend upon temperature. Under an imitation of the natural temperature, the chymical analysis, if it were sufficiently perfect, would detect the presence or absence of combinations in the artificial compound when compared with the natural product of the intestine which are attributable to the want of that spiritual agency, which will have a share in every process belonging to a living body.

§ 7. This chymical investigation in the present state of our information would most probably serve but to illustrate the necessity of the operation of that principle which has no substitute in the laboratory, or, by shewing us how much may take place without spiritual properties, to indicate what, or how much is accomplished by them. But as all this belongs to particular inquiry with which I do not now profess to be engaged, I shall state the history of the function in that imperfect way which will at least render it conformable with the preceding views.

§ 8. In the progress of experiment, it may perhaps be decided that the chymical changes which chyme undergoes, in order to become chyle, may result from the combination of the former with the intestinal fluids, &c.; or, it may be discovered, that an approximation only to a similitude takes place between the natural chyle and that produced by an artificial mixture of the duodenal fluids with chyme. But, in a general view of the subject, it does not appear necessary to decide upon this matter, since, by tracing the agency a little higher, we shall find that both the alternatives resolve themselves into one common inquiry.

§ 9. If the processes of the conversion we are considering are but partially accomplished by the mixture of intestinal fluids with chyme; or if this conversion takes place but imperfectly, under circumstances similar to the latter, save that the principle of life is extinct; then, that, the absence of which renders the conversion imperfect, may be considered, when it exists, as a product of the direct operation of vital properties upon the constituents of the material with which they are related. But if the intestinal fluids should be found capable, without the presence of a principle of life, of accomplishing a perfect conversion (which is perhaps scarcely to be known), then the relation of the principle of life with the constituents of chyme is mediate. The difference is, that in the one case (the direct) life produces changes in chyme, in which the fluids do not co-operate; and in the other, that life produces fluids which accomplish the changes which chyme undergoes in its conversion into chyle. I will not with our present facts decide whether either of the relations just mentioned is exclusive, or, if mixed, how much is assignable to each; but after bestowing

a few words upon the last (supposing it in conformity with general opinion to obtain at least to some extent), I shall proceed to inquire into the laws of that which we perceive to be mutually essential, viz. the spirit which presides in the seat of these operations.

§ 10. The chymical constitution of chyle being determined by appropriate analysis, it is to be asked whether such a chymical production necessarily involves that state of the elements of informal life which is essential in this stage of preparation for the maintenance of the living principle? or, whether latent spiritual changes do not take place in this conversion, to which the chymical are, so far as regards subsequent relations with life, mere accompaniments?

§ 11. To ascertain this point is perhaps beyond the scope of experiment. The constituents of chyle, such as they are mentioned by chymists, may be easily drawn from foreign sources, and put together. But we cannot thus ascertain whether this artificial combination involves the prepared state of the spiritual elements, unless it were possible to keep an animal alive, by filling his lacteals with this production of the laboratory, without subjecting it to the influence of the stomach or intestines; an experiment not likely to be attempted, and still less likely to succeed.

§ 12. That a process so complex as that of chylification should be performed merely for the purpose of producing a few chymical constituents (such as have been enumerated in books) appears very improbable; and we have the more reason to suspect that the latent are also the most essential changes, when we consider that if an animal were fed with chyle, or substances which approach very near to it, the same conversions, or nearly the same, would take place as when fed with ordinary food. An heterogeneous mass would be produced by the stomach and duodenum, and the agents, so far from availing themselves of a chyle ready made at their hands, would still go through the regular business of preparing a part for the purposes of the animal, and another part which is termed excrementitious.

§ 13. Indeed, whether the chymical involves all the changes which occur in the formation of chyle, or whether others exist, of the spiritual kind, which are superadded to the chymical (chyle being made a medium for their circulation), it seems scarcely worth while to inquire; since it is clear, 1st, that chyle possesses properties which concur to maintain the assimilating spirit; 2nd, that the fluid, or medium of these properties, will not support the assimilating spirit, if the changes which are produced in it in any stage of its passage through the preparatory organs be omitted; and, 3rd, that therefore, the function of every seat of these organs is to produce changes, which, among other purposes, refer to the aptitude which must subsist between the elementary and the formal life.

§ 14. This business, this progressive adaptation, may take place in two ways, or by a complication of them: 1st, it may be, that

the principle belonging to the preparatory structures may be consumed in separating from the fluid destined for nutrition heterogeneous substances or properties; or, 2nd, that the living properties of the textures passing into the fluids destined for nutrition, and becoming again informal life, may determine the due relation between the nutrient material and the peculiar nature which it is destined to support.

§ 15. Whatever the precise nature of these curious processes may be (and which, for want of the sense which we have so often alluded to, we shall never understand) this law appears common and universal to the living specimens of both kingdoms, viz. that though an immense variety of animals (and vegetables) of the same genus may derive their support from the same aliment, yet the condition upon which the life and corporeal character of each are maintained is, that the aliment for such purposes should undergo a preparation by the organs of the living form which it is destined to nourish; nay, so essentially and peculiarly is the function of the preparatory organs related with the diffused life and textures, that blood itself, from an animal of the same species, thrown into the system of the circulation, will not prove a substitute for that fluid whose properties are endowed by organs, in conformity with a natural and specific relation.* To this general view we shall perhaps have occasion to return. Having shewn the necessity of the operation of the living principle belonging to these organs, we are next to consider the laws which belong to the principle itself, or at least to exhibit some alternatives respecting it.

§ 16. We have seen that the operation of the organic spirit belonging to the structure of the intestines is either direct or through the medium of the fluids supplied to the chyme. There is a deficiency of facts to prove whether indeed the former mode occurs at all, though, for the reasons stated, it appears probable. It is now to be inquired, 1st, whether those spiritual properties which are engaged in the conversion are those of the assimilating life; or, 2nd, whether they are that conjoined result which we have expressed "the regular dependent;" or, whether they are of the

* The only instances of nutrition by a material prepared by foreign organs are those exemplified in the engrafting of animal and vegetable substances. In these cases, the life of the foreign substance must in its properties and constitution so far resemble that of the substance with which it is united, that the material which is prepared for one agrees with common properties of both. When substances are in this way united, the foreign or additional one commonly preserves its own character, or takes only itself out of a material which possesses its properties as well as those of the organization with which it is allied. In such cases, the affinity between the substances is only of resembling properties, without constitution or the production of a differential. In other cases which are perhaps exceptions, the growth and product of the foreign substance is modified by its new connexion. In this case there is not only an union of common properties, but communion of other related ones giving rise to change, or constitution: as in generation, some properties of the parents mix and modify each other, and some preserve their separate and original character.

occasional kind. So far as these questions can be decided will occupy but a short discussion.

§ 17. It matters but little which of the agencies we have supposed to occur in this conversion is chosen as an example; whether the direct spiritual, or that through the medium of the secretions; the latter is the more probable. As the effects of the functions of the intestines have never been observed except during the integrity of the organs, and whilst their connexions were preserved; we cannot, in the present state of the facts, pronounce that they derive properties from any distant source necessary to their function. Hence, we cannot, from any evidence which has been attained respecting these parts, affirm that their function, or any part of it, is produced by that life which we have called the regular dependent.

§ 18. As the secreting function of the intestines (or the superior ones of which we are chiefly speaking) is unremitting, so in deciding by what form of life it is accomplished, our choice lies only between the assimilating and the regular dependent. But, as the conversion of chyme into chyle is not equally unremitting (seeing that there are times when the duodenum may be supposed, if not empty, to have accomplished the end of its function upon the chyme discharged into it), so we cannot affirm but some part of the process may be dependent upon the occasional life. In other words, it is to be inquired, if it should be found that the operation of the vital properties is not wholly through the medium of the secretions, whether those properties operating directly which are engaged in the conversion, are latent in the structure of the intestines, or whether their presence is excited or derived by a disturbance of natural or quiescent relations, which might occur upon the introduction of a substance foreign to the fœtal condition. My meaning will be found more fully expressed in the beginning of the article on the stomach.

§ 19. In the case of the stomach, the operation of the regular dependent life has been assumed, 1st, because the secretion is unremitting, which decides it, if dependent, to be regular; and, 2nd, because the secretions have not been found to take place, when the communication of the stomach with a nervous centre has been intercepted, which last, if the experiments may be relied on, proves the dependence.

§ 20. But, in the case of the stomach, as in that of the intestines, it would be difficult to decide on the question of an occasional dependent life; seeing that the dependence of processes which might involve the direct operation of spiritual properties, in digestion on the one hand, and in chylification on the other, cannot be known but by a division of nerves, which might prevent or impair those secretions from defect of which all the other agents of the function may be rendered inefficient.

§ 21. In order to decide whether the conversion of chyme into chyle is attributable in any way to properties derived from a foreign source, the faint success which has been obtained in some

such inquiry indicates, for the purpose of confirmation, that it should be observed, whether the conversion takes place under a division of the nerves which supply the intestines, or any sufficient portion of them, to constitute an adequate field for the observation. If the conversion did take place, the independence of the functionary properties of this, on any other, seat is proved: if it did not take place, it decides that the unremitting processes require properties of the regular dependent kind; but the experiment is not decisive in regard to the share of the occasional properties.

§ 22. If we were to yield our assent to the indication of a partial analogy, we should say, that as the secretion of the stomach seems to depend regularly upon the communication of properties from a distant seat, so it is probable that secretion in the intestines acknowledges a similar dependence; and extending the argument of analogy, which is indeed here very weak, we should say, as in the animal system, properties which act occasionally are found to be obtained in the seats where they act, only by the presence of something foreign to the state of life during the earlier periods of fœtal growth: so, applying this fact to the present purpose, we should conjecture that the modes of the operation of life in chylification were mixed, and that the direct was also that which we have distinguished as the occasional. Both these analogies are, however, too imperfect to justify any certain conclusion.

§ 23. There are those who would reason on the supposed dependence of digestion, &c. upon a distant source, by citing those well known examples of the suspension of the process of digestion, together with the disorder producible in the bowels by passions and emotions of the mind. They would argue, Is it not clear that digestion depends upon the brain, when we have all had experience that anxiety will destroy appetite, that sudden anger or sudden grief will suspend the digestion of food already taken; and that these things occur by affection of the brain, as is proved by their taking place through the medium of a sense, as when a person *reads* a letter, or *hears* an oral account, &c.?

§ 24. The persons who argue thus do it upon a ground the fallacy of which we have sufficiently exposed, but which may here be in part repeated. If one seat is influenced by a process of change which commences in another, the influence takes place in one of two ways, either by conferring upon the secondary seat new properties, or by suspending the communication of habitual ones. Seeing that secondary change is liable to these alternatives, we are to consider the mode of discriminating between them. The mode of discrimination has been already stated: it is by ascertaining by the test of intercepting the medium of intercourse, without communicating a foreign influence, whether the effect (digestion, or any thing else) will take place under such circumstances. If it does take place, the independence is proved: if it does not take place, it will afterwards remain to be decided whether a secondary affection, which takes place from an occasional disturbance of a primary seat

by a foreign cause, involves the natural or regular dependent communicated properties; or whether it is produced by others, arising out of a new condition, so far distinct from the natural, that the medium of communication subsisting, the secondary affection may occur where there was no natural communication of properties of the regular kind.

§ 25. In addition to the analysis of chyle, which has been suggested for the purpose of enabling us by an artificial combination of the constituents detected to decide whether even all the perceptible phenomena of the conversion are dependent upon chymical agents, there remains to be remarked, in the chymical department, the precise share or import which each secretion has in the common result. Thus, it is to be inquired, how much of the conversion is performed by the constituents of intestinal mucus; how much by the biliary; and how much by the pancreatic secretions. This investigation is to be prosecuted not merely with a view to the general result of the combination of one or more of these fluids with chyme, but relations of constituents are to be sought after, and the combinations and changes among them to be specified, and this respectively according to the threefold division of the spiritual, chymical, and mechanical departments. Such an inquiry, to the extent permitted by the imperfect means of analysis which we possess, is not difficult; but this same imperfection in the means of analysis would most probably render it of no value.

CHAP. IV.—*The Liver.*

§ 1. THE function of the liver is said to consist in the secretion of bile. Is this the only way in which it is related with the animal economy? As the function of this viscus has never been investigated with minuteness, we are destitute of the facts which would enable us to decide satisfactorily upon this question. It is, however, to be presumed that the separation of bile from the blood in some way or other makes a part of the general concurrence of processes for the maintenance of life and health; and that in this way the function of the liver may not be without its use, independently of any further purposes to which its *product* might be applied.

§ 2. I am not aware that we possess any direct facts which prove a relation with the animal economy of the kind just suggested. And indeed it seems almost impossible to attain such facts; for the only mode of ascertaining that the separation of bile from blood is salutary, or fulfils an important end, is by witnessing the event of the suspension of this secretion: and here we have to discriminate in the subsequent derangement (if any) whether such derangement is to be imputed in part, or wholly, to the presence of bile in the blood, or the want of it in the intestines; or, if to both these causes, the share is to be decided which is attributable to each.

§ 3. But that the mere separation of bile from the blood contributes towards the well-being of the animal is to be presumed from the analogy of this, to the secretions, which are also excreted, serving no ulterior purpose, and therefore not liable to the confusion above noticed; as in the case of the urinary secretion, the suspension of which is known to be productive of disease, and its restoration to be followed by a return to health. The use of the mere separation of bile from the blood is rather to be supposed upon this ground than from the phenomena of jaundice, which are liable to happen in two ways, between which we have no unequivocal criterion for the purpose of discrimination. To which may be added, that supposing the disordered functions of distant seats, which usually take place in jaundice, to be clearly imputable to the presence of bile in the sanguiferous system, this would prove only that bile

in the blood, which has never been separated from it. That such an absorption takes place it appears reasonable to infer from the circumstance that, in jaundice, bile may be copiously secreted with the urine, and if this bile had not been previously separated by the liver, there is no reason why the kidneys should not at other times produce bile, seeing that the blood cannot be at all other times free from the materials of bile, because its secretion by the liver is unremitting. Leaving this, then, as a matter which would not be the worse for some additional illustration, we shall proceed to consider some particulars belonging to the liver as one of the preparatory organs.

§ 4. As bile is mixed with the chyme discharged by the stomach into the duodenum, it is to be inquired what share has bile in the conversion of chyme into chyle? This inquiry proceeds upon the supposition that the liver is not *directly* related with the preparatory processes, but through the medium of the fluid it produces.

§ 5. An opportunity is afforded for a comparison between the chymical differences of chyle with which bile is mixed, and that into the composition of which it does not enter, by a ligature on the bile-ducts. But would a specification of these chymical differences illustrate or explain the importance of bile in these processes, with regard to the future relations of the common product of these organs? To proceed in the analysis, in the way indicated by our causation,

§ 6. It is to be asked, with what bile exhibits the first relation? with the contents of the duodenum. Bile is mixed with chyme, and helps to constitute chyle; this is the first operation in which it is engaged: but its history is to be more minutely traced. Chyle is separated into two parts: one, nutrient, which is taken up by the lacteals; and the other, excrementitious. Concerning this separation, it is to be asked, does it happen from spontaneous processes which chyle undergoes from the force of its constituents? or, is there an additional function, viz. that of the lacteal orifices, by which the separation is performed? This is a matter which will be recurred to hereafter: in the mean time, if the separation is spontaneous, the parts are first to be defined; it is then to be inquired what those properties are which determine the separation, or without which it would not take place? The agents are to be sought after, distinguishing efficient properties from associated ones (a shrewd work this for analysis); and the share which *bile* has in the operation is to be specified.

§ 7. But without laying any stress upon the result of an inquiry on the above question, we will proceed only in our examination upon that which is obvious. As the separation of chyle takes place, the constitution of either part is to be sought after, if possible, by analysis. It is to be asked of the lacteal chyle, does bile contribute towards its constitution, or does bile furnish any requisite constituents? The philosophical mode of answering this

question would be, 1st, by obtaining an accurate knowledge of the constituents of bile; 2nd, by an analysis of lacteal chyle, with a view to the detection in it of the constituents of bile; 3rd, by ascertaining, if any constituent of bile should be found in the lacteal fluid, that it is furnished by bile, and not by any chymical or animal process elaborated on the common intestinal material. This is to be ascertained by preventing the entrance of bile into the intestines. Here it will be argued that if bile furnishes any such property, it is not an *essential* one, seeing that life has been in various cases continued where the secretion of bile is suspended. But as the analysis suggested, even in these cases has never been made, so it cannot be pronounced that here there is not a deficiency of properties or substances necessary to healthy lacteal fluid. Besides, this would be arguing from an exception, which at most can never reflect but a dubious light, because it pre-supposes that the analogy is imperfect. A person may live for a month without taking any thing but gruel or water, and this may be vomited as regularly as it is taken into the stomach (*quod vidimus testamur*), but it does not follow that a person in a natural or healthy condition can live a month without better nourishment, even though the progress towards death should not be aided by incessant vomiting, &c.

§ 8. It will be further observed that if bile contribute any thing towards the constitution of lacteal fluid, it is by a decomposition of itself, since the colouring ingredient of bile, whatever it might be, does not, if we may judge from the absence of its usually perceptible effect, enter into the composition of lacteal chyle.

§ 9. Having, by the analyses we have sketched, determined what changes are produced by bile in the material with which it combines, what changes take place in *related constituents* as well as in the general mass, what decompositions ensue, what new alliances are formed; having fully ascertained the changes and processes which take place in consequence of the mixture of bile with the intestinal material; it is next to be inquired concerning the other relations, as those subsisting between the chyle of the intestines and the properties of their structures, in the establishment of which the constituents of bile might have some share.

§ 10. The question more simply stated is this, what is the relation of bile with the vital properties of the intestines? Here again we must recur to our analysis: we cannot ascertain what is to be attributed in this way to the operation of bile, unless we know what takes place without it. We should say also in this instance, in order to understand whether bile concurs with the vital properties of the intestines to produce phenomena, we must first be able to take cognizance of the class or kind of phenomena to which our conjectures relate: having attained this faculty, we have then only to inspect the phenomena which take place under the usual and natural influence of the bile, and afterwards, having tied the bile-ducts, to observe what changes occur upon its privation; and if we wish for further satisfaction, we might repeat the

synthetical process, and, removing the ligature from the bile-ducts, observe whether those first phenomena recur which were remarked under the natural condition, and found to cease upon the prevention of the presence of bile. However impossible or even absurd all this may seem, until it is fairly and fully accomplished, I shall take the liberty of saying, that the offices of the bile, the results of the function of the liver, have never been successfully investigated. Let others be bold in professing knowledge: for my own part, I find that the profession of ignorance is much more becoming, and am apt to believe that there would not be half so many puppies in the world if men were as honest in confessing their real deficiencies, as they are ingenious in gaining credit for better qualifications than they possess. Let us, however, bestow a few words upon the popular notions on this subject.

§ 11. There are those who pretend to know all about it.—The use of bile? why, say they, is it not the natural stimulus to the intestines? does it not help to produce their peristaltic motions? would the bowels act without the presence of bile? Such is the explanation which some men, who pass for shrewd ones too, will offer. Bile, then, say they, is the natural stimulus to the bowels. I would ask what is meant by a natural stimulus? I presume that as a stimulus is a something which produces an effect, it is another name for a *cause*, which is the ordinary term by which we express those things upon operations of which changes or results depend. But the word stimulus, it will be said, does not imply *the* cause of the motions of the bowels, seeing that these motions may take place without it; but it designates an adjunct to the other powers, a something that gives energy to the other powers, tending to the same end. Then the stimulus of bile, instead of being *the* cause, is *a* cause of the motions of the bowels. Is there, I would ask, any proof that the bile is either *the* cause or *a* cause of those motions of the bowels by which the fæces are expelled? This is a matter which may be argued at some length. It may be said by those who assign the above office to bile, that diarrhœa always happens when the intestines contain a preternatural quantity of bile. It may be said, in reply, that it is not proved that the bowels contain, in the cases alluded to, a preternatural quantity of bile; for the bile which is vomited in cholera may be no more than a misplaced portion of the natural quantity, and that which is evacuated from the rectum may also belong to the natural quantity of bile, which appears to be increased by a mixture with a large and preternatural proportion of the visceral secretions. Besides, granting in this disease the quantity of bile to be increased, the action of vomiting and the supposed quickened, or inverted peristaltic motions of the bowels, as at other times they all take place when there is no reason to suppose a preternatural quantity of bile, and, as in cholera, the sickness, &c. often continues when bile ceases to be discharged, so these actions may be *concomitant* only with an increased secretion of bile, or the unconnected particulars of a general affection.

Then, say the gentlemen, who will have bile to be a stimulus, what gives origin to that commotion which takes place in cholera, if it is not the presence of such an additional stimulus? This is a ridiculous question, replies the opposite party; it may be just as well asked what gives origin to the increased secretion of bile, or how disease of any kind ever happens spontaneously? It is then urged by the stimulators that the bowels are most regular when the secretion of bile is the most natural. Aye, say the others; but the bowels are sometimes the most active when there is no evidence of the presence of any bile, as we have witnessed in those who have had frequent and loose evacuations almost white, and accompanied with much griping and tenesmus. It may be further urged, on the same side, that the stools of those of the most costive habits appear, so far as may be inferred from their colour, to contain the largest proportion of bile: it may be noticed too that persons may have stools of the usual appearance or even lighter for some time, when, upon the the exhibition of a purgative, dark scybala may be discharged, which, so far as may be judged *a priori*, and from appearances, had lain a long time in the intestines. Now if these scybalæ are made dark or black by the bile they contain, how comes it that portions of fæces, apparently containing the most bile, are not discharged so soon as portions containing less, if the action of the intestines is stimulated by bile? These and such like witticisms may be pursued on both sides, at great length, but it is a subject on which little or nothing is proved; I shall therefore hasten to take leave of it, merely suggesting to the stimulators, that if the functions of animal bodies are to be explained by a reference to *efficient causes, precise relations*, and *real agency*, it must be done without calling in the aid either of whips or spurs.

§ 12. But it will be asked seriously, does not then the bile contribute towards those actions of the bowels by which the fæces are expelled? To this I reply, the inquiry is analytical, it has never been attempted: and, unless we should gain some unexpected lights from collateral knowledge, it never will be attempted with success, until we have acquired that other sense of which we have before spoken.

§ 13. There are others (I rejoice to say, very few) of those bold theorists, men of some place too, who will tell us the use of bile as easily as they can reckon their fingers. And of what use do they say it is? Why, truly, to make fat: so weak, so silly and extravagant a notion is very much below scrutiny. Let it suffice to say that a child of ten years old would discriminate that such an inference was not warranted, if the shallow grounds of it were clearly stated to him. Suppose I were to assert the use of bile to be, that the souls of elephants, formed in the air, imbibed by the earth, taken into the stomach, and embodied with our food, should, by its operation, be freed from purgatory, where they had been confined for their sins, passing away into their native air, in a

smoke, fitted for Elysium, &c. Suppose I were to assert this, no one could prove that it was not so: the most that they could say is that *there is no proof* of the existence of the souls of elephants in the bowels. Just so with the assertion about the fat: I will maintain that there are the souls of elephants in the bowels, with just as correct a reasoning as that which has been cited to prove that the use of bile is to form fat. Quitting these puerile pretensions to ingenuity, let us return to our indications of an analysis.

§ 14. It has been stated in the preceding pages of this article, in conformity with the prevailing opinion, that the principal end of the function of the liver is to secrete bile: that it does this there can be no doubt; and that the result has a reference to certain purposes in the animal economy, or at least that it produces certain effects, is equally clear. The object of investigation is to shew what these effects are, and the strict mode of analysis, by which this object may be attained, has been imperfectly pointed out. Having said thus much concerning the uses or the effects of bile, it remains that we should inquire a little into the history of its own formation.

§ 15. The structure of the liver has been minutely examined by anatomists, and is well known to every student, so far as it has been described. The anatomists inform us that bile is produced in minute tubes, expressed as the acini, pori biliarii, &c. or secreting structure. The processes, or manner of secretion in general, will hereafter be more particularly considered under that title.

§ 16. As the secretion of bile has never been found to take place in the dead subject, and as this secretion, unless prevented by disease or malformation, is found regularly to take place when life is present; and as the only variety in tubes must consist of their comparative size or shape, and as no specimen can be supposed to exist in one place, which has, among myriads of tubes existing in every structure, no parallel elsewhere; so it is to be inferred from these data, 1st, that the organic spirit, or the living principle belonging to the secreting structure of the liver, is necessary to its product; and, 2nd, that as the same secretion does not take place elsewhere, although a similitude in mere structure and material is assumed to obtain, so the spirit, which is said to be essential to the secretion of bile, is a peculiar one, or a modification of that general one which is identified in all seats by the exhibition of common properties.

§ 17. The peculiarity of the spirit in this seat is for the present rested upon the above grounds, which are confessedly assumed. The questions which might arise upon it have been in part discussed in the chapter, "General Relations of Spiritual, Chymical, and Mechanical Agents," and what remains to be said upon it will belong to the article on Disease. For the present, the settlement of the difficulties involved in the proposition is unimportant, and would therefore be misplaced here.

§ 18. Whatever the nature of the spirit which resides in the secerning tubes of the liver might be, whether peculiar or common, the dependencies of the spiritual formations of one part upon the

relation subsisting between these and others belonging to a different seat, suggest, on the ground of analogy, that the existence of a similar dependence should be investigated in this instance. It is to be asked,

1st, Is the spirit, which by its relation with venous blood forms bile, the regular assimilating life of the structure? or,

2nd, Is it dependent upon the vital properties of another seat? and, if dependent,

3rd, Is the dependence regular? or is the communication constant, by the force of a natural relation? or is it of the occasional kind?

§ 19. In this case also, in inquiring into a dependence, it is our first suggestion from analogy to intercept the communication of the hepatic nerves with their centres. This should be done so near to their entrance into the liver as to obviate any confusion which might arise from considering the communication with their ganglia as equivalent to a connexion with the brain or spinal marrow. The result of this experiment would be, either that the secretion of bile proceeded as usual, or that it was suspended. If the former, the independence of the functional spirit of the liver of properties existing in the seats of the nervous centres would be shewn; if the latter, viz. that the secretion of bile was suspended, then it would be inferred that the functional life of the liver acknowledged a dependence upon a distant seat. This inference would be sanctioned by certain analogies, proving that where there is no dependence the injury inflicted by simple division does not tend to suspend or impair organic processes. The dependence in this case, as before suggested, would be one of two kinds, either for the receipt or the privation of certain properties, by the force of a distant relation; which of these remains to be discriminated, for which purpose we are not without some analogies.

§ 20. With respect to the third question, viz. whether, the dependence being proved, it is of the regular or occasional kind, this is to be determined only by observing the conformity of the result of the function with these alternatives respectively. It will be asserted that the secretion of bile is *unremitting*, and that therefore the communication which makes the dependence, if any, must be so too. That bile is unremittingly secreted is probable, and if it is not, I do not perceive to what occasional cause an irregular communication can be ascribed in this instance. If a summary of the function of the liver were to be attempted upon an imperfect evidence on many points, furnished by loose and distant analogies, it would be of the following kind.

§ 21. Bile is produced by the secerning structure of the liver. It is produced by a relation which subsists between the functional life of this structure and venous blood. The functional life of the liver is of the regular dependent kind: that is, the *assimilating* life of the structure is so related with arterial blood as to produce itself, or to separate and unite its elements; properties communicated from another seat unite with the assimilating life of the secerning

structure of the liver, and constitute the *functional life:* such a relation subsists between these two sets of properties, in the assimilating and the acquired; while the latter, or the properties obtained from the distant seat, being only *certain properties of life,* and not an assimilating principle, do not produce themselves from the blood of the structure to which they are transposed, but merely unite with the assimilating spirit of this seat and expire with it, requiring to be renewed from their own source. These united properties, the identified functional life, by its relation with *venous* blood, separates bile; the laws of which separation will be hereafter spoken of under the head of secretion. The bile thus produced is mixed with chyme, and assists in those changes by which it is converted into chyle. The use of bile is either wholly confined to the processes of the alimentary canal, or else it gives some properties, independent of its colouring principle, which being combined in the lacteal fluid have a reference to some future offices in the animal economy, which arise out of the relations of blood. The kind of investigation (analytical or synthetical, or both) which would enable us to decide upon these present difficulties, is imperfectly sketched in the preceding pages. Chymistry has detected certain substances, belonging to bile, in its department: the chymical investigation, so far as it has been honestly conducted, is no doubt laudable, as is every sincere attempt to augment the sum of our intellectual wealth; but as the chymical investigation has not yet elucidated a single question upon which we have any interest in being informed, the exhibition of its results may here be dispensed with.

CHAP. V.—*The Spleen.*

§ 1. THE spleen is enumerated among the preparatory organs, because from its situation and connexions it appears to belong to the system of the chylopoietic viscera. It is supposed that its use, if it has any, is one subservient to the preparation of food, but there is no absolute proof that it contributes any thing to this purpose. The same might be said of the liver; at least, as remarked in the last article, it is not ascertained what share bile has in those intestinal conversions which are necessary to the maintenance of life. The analogy holds good no farther than that there is mutually an absence of demonstrative proof: but, in the case of the liver, a product of its function is perceived, the destination of this product may to some extent be traced: it is seen to mix with food, &c. and that it tends to accomplish some useful purpose in the system, is believed, agreeably with an extensive experience, that no regular operations of this kind, which we have been enabled to understand, take place in animal bodies without a reference to such future purpose. The spleen furnishes no product: and as we are not acquainted with the manner in which any similar viscus extends its function beyond itself, we are left to conjecture concerning the mode in this instance, without the support of any, or but a distant, analogy, deduced from the phenomena of animal life.

§ 2. We are nevertheless disposed to assign some use to the spleen, on a ground which differs from that on which we assign an use to the liver in these respects, viz. that the use of the former is supposed from a general analogy, and that of the latter from the particular analogy which obtains between it and other secreting organs. We observe in a general way, that there is no part of an animal body without its use, and when an apparent exception occurs, in agreement with our general experience, we presume that our ingenuity has been insufficient to discover the designs of Nature, rather than that she has made the object of our suspicions in vain. Let us, however, having stated the grounds by which we are induced to seek a function of the spleen, take a short view of the more particular manner in which the inquiry respecting it has been conducted.

§ 3. The spleen, as is well known, has been removed from dogs, and the animals have not only survived but have appeared to suffer

no inconvenience in some instances from its loss. This fact proves that the use of the spleen, if it has any, is but of trivial importance; accordingly, a function of the *hydraulic kind* only has been supposed to belong to it. It has been considered, ingeniously, as a mere reservoir of blood, subservient to the function of the stomach. The theory alluded to is this: when the stomach is distended by food, it compresses the soft texture of the spleen, diminishing the quantity of blood which would otherwise pass to the splenic arterial ramifications, and thereby determining a greater quantity to the stomach, through the vasa brevia and gastro-epiploica sinistra, branches given off to the stomach, in the course of the splenic artery to the spleen. The theory further assumes, that the stomach receives an augmented supply of blood, at the times when it is most required, for the purposes of digestion.

§ 4. That such an effect may take place from this arrangement, in some degree cannot be denied; at the same time it may be suggested that the pressure which the stomach may, under any circumstances, be supposed to exert, is scarcely sufficient to diminish the area of an artery of the smallest size, when blood is forcibly impelled through it with the usual velocity of the circulation. It may be suggested, that the momentum of the blood, circulating in the spleen, presents a considerable resistance to any cause of compression, and that the resistance is likely to be the more effectual, when the *compressing substance* is from its texture and configuration (that of a membranous cavity *partially* occupied by *fluid contents*) even more easily compressible than the spleen itself. Some truth however may be allowed to this theory; and the trifling degree in which the spleen, according to it, can be conducive towards any useful purpose, agrees very well with the slight derangement which has been observed to follow its entire removal. It may be observed further, in the way of objection to this theory, that determination of blood to particular seats takes place either regularly, or at intervals in many, perhaps in most, diseases; and that such determination is produced without any such arrangement as that which is here supposed to be merely subservient to it. But, without drawing our examples from the phenomena of disease, we may quote one instance in which the occasional increase of the quantity of blood, circulating in an organ, takes place indispensably for the purpose of an occasional function. In this instance (furnished by the phenomena of the pudic artery) nature is seen to accomplish the increased determination of blood to a part with no other mechanism or contrivance than that which belongs to its own vessels, which are made liable to a general, and an occasional state of dilatation. It must be observed in regard to the spleen, that the fact just quoted furnishes an analogy against the theory proposed respecting it; and further, that we perhaps ought scarcely to conjecture that complicated means are at one time instituted by nature, for a purpose which is in other

instances observed to be accomplished by the most simple. Enough, however, of this.

§ 5. Another theory which has been proposed in explanation of the use of the spleen is, that it is a viscus to which a large volume of arterial blood is sent, for the purpose merely of its conversion into venous blood; that the object of this conversion is to supply to the liver an adequate quantity of that blood from which bile is secreted. This theory is perhaps better supported by perceptible occurrence than the last; the blood from the splenic vein certainly goes to the liver, and if bile is secreted, as is from other circumstances made probable, from venous blood, then the spleen must have a function of this kind by which it is related with the office of the liver. These theories, perhaps, may, either singly or both together, make up the true account of the use of the spleen. That it is not a secretory organ is obvious: we have therefore, in considering its vital properties, to determine only concerning the laws of those which belong to a structure made up of arteries, veins, nerves, membrane, &c.; exhibiting, either individually or collectively, no function which is not every where common to these components of the textures.

§ 6. According then to the analogy of the mixed structures, and according to the test of division, which has already been sufficiently spoken of, we should at once decide that the life of the spleen is simply of the assimilating kind. The only manifest conversion of fluid which takes place in it is that of arterial into venous blood; a process which goes on alike in the paralytic limb, or in one, the nerves of which have been divided, and in that whose animal character is entire.

§ 7. If, then, the spleen can scarcely be suspected to be related with the preparatory processes, in any except the subordinate way suggested by the preceding theories; if such is the only way in which it concurs *mediately* with the digestive organs; it is next to be inquired, if it contributes *directly*, by a relation with the spiritual properties of adjoining structures, to the common end? In answer to this question, it need only be remarked that we are precluded the precise analytical and synthetical tests in examining relations of this kind. We can merely ascertain the existence of such a relation, and we infer it when regular phenomena are modified, or made to cease by intercepting communications between parts, and when there is no reason to suspect a mediate relation, established by the intercourse of fluids. Hence, as the spleen has been removed, with no other effect or influence of the direct kind than that which might be supposed to arise rather from the infliction of an injury than from the privation of accustomed properties, we possess no evidence by which a relation of this sort may be established in the present instance. Indeed the fact just cited proves, that if the spleen has any use at all, it is not worth inquiring after; a sufficient ground for dismissing it from our present consideration.

CHAP. VI.—*The Pancreas.*

§ 1. OF this viscus it is sufficient to say, that it is liable to the same order, and furnishes nearly the same objects, of investigation, as those which have been suggested with respect to the liver.

§ 2. The end accomplished by the function of the pancreas is first to be inquired after. Its structure is glandular, and it pours a fluid into the duodenum. What is the importance of this fluid? This question is to be answered by an analysis, many times indicated, and therefore requiring here no repetition. Is it useful only in the processes which are conducted in the intestines? or does it furnish properties which constitute a part of lacteal chyle, and have a relation with the animal economy, through the medium of the circulation?

§ 3. Having determined the importance or objects of the pancreatic secretion, it is next to be inquired whether it has any other mediate relations? The one suggested as comprising the function of the spleen, viz. the deterioration of arterial blood, will occur as one other mediate relation; and in this respect the pancreas, in common with the other abdominal viscera, appears subservient to the purposes of the liver.

§ 4. The direct relation, if any, of the pancreas with adjoining organs, is next to be sought after. The mode of conducting such an inquiry has been pointed out, so far as is compatible with our limited means of cognizance. But as there is no reason to suspect the existence of any relation of the direct kind between the pancreas and the other preparatory organs, so it is superfluous to be more minute in our indications respecting it.

§ 5. The chief use of the pancreas appears to be that of producing a fluid which mixes with the common material of the intestines. It remains only to inquire into the history of this secretion. The dependences of it are to be sought after; as whether it is a product of the assimilating, the regular dependent, or the occasional life: with the investigation which has been proposed as appropriate to these respectively.

CHAP. VII.—*Mesenteric Absorbents.*

§ 1. DO these vessels merely serve the purposes of tubes, or have they a function superadded to their mechanical construction?

§ 2. If the absorbents of the mesentery had a relation of the mechanical kind, and no other, with the contents of the intestines, there appears no reason why the *peculiar fluid* which is found in them should be taken up, rather than some others which also make a part of the intestinal contents. There are sufficient grounds for supposing that bile is poured into the bowels, sometimes, in considerable quantities; yet it does not appear that bile is taken into the lacteals, or any of those almost aqueous fluids which exist in the intestines, and are tinged with bile. If it be said that bile is too thick a fluid to enter the orifices of the absorbents, the same cannot be said of these aqueous fluids: nor, indeed, is the objection with respect to bile itself founded on analogy. To put this discussion into a briefer form,

§ 3. Fluids existing in the intestines, and of a tenuity which renders them capable of permeating the lacteals, are not taken up by these vessels. Certain other fluids, constituting one of a pretty uniform character, are taken up by the lacteals. The inference from these facts is, that the lacteal orifices exercise a function of the elective kind, by which some fluids are taken into them and others rejected.

§ 4. The great proportion of watery liquors taken into the stomach pass off by the kidneys or skin: as when a person drinks two quarts per diem, and has a costive stool once in two or three days. It matters but little how the qualities of these liquid ingesta are varied; whether cyder, beer, lemonade, water, wine, tea, coffee, gruel, or medicated drinks, or these mixed, they all enter the lacteals to pass off by urine or sweat. From this fact we should be disposed to infer that fluids pass from the intestines into the lacteals merely according to hydraulic laws. But this inference cannot be made positively, because the fact is liable to another explanation; and we require some further facts to decide which is true. A function of the above elective kind might be exercised by thelacteal orifices on all these fluids; that is, they may possess some properties in common with which those of the absorbents are related.

§ 5. Hence the alternatives to be decided upon in this stage of the inquiry are, whether the entrance of fluids from the intestines into the mesenteric absorbents is a process wholly hydraulic or wholly functional, or whether not exclusively either, but of the mixed kind? These alternatives may be discussed by consulting analogies, &c. to some length; but as we do not possess the facts which will justify any very positive conclusion, I shall leave them as alternatives on which our decision is suspended.

§ 6. Although we cannot determine whether the hydraulic processes have any, or how great, a share in the entrance of fluids into the lacteals, it will scarcely be doubted that the orifices of these vessels operate processes upon the intestinal material of the functional kind. We know that the fluids of the intestines are mixed, and that it is inconsistent with analogy (as well, perhaps, as verifiable by direct experiment) that the separation of lacteal fluid from this mass should be performed by a mere mechanical filtration, or a mere capillary absorption. If then the separation is an animal process, in some respects resembling secretion, it is to be investigated rather according to the laws of life than of inanimate matter.

§ 7. Does any lacteal absorption go on after death? An animal may be killed a few hours after a full meal, at a time when it might be presumed the nutrient fluids exist copiously in the bowels: it is possible that, under these circumstances, by examining with a magnifier one or more lacteal trunks, the contents of which are compressed out, it may be ascertained, either by their filling again or remaining empty, whether lacteal chyle is separated and absorbed from among the general contents of the intestines *after life is extinct.* The peristaltic movements may be imitated, or the contents of the small intestines agitated, with a view to facilitate mechanical separations; and under the experiment the animal temperature may also be preserved. If no absorption took place, as from analogy seems most probable, it would then be decided that this instance of absorption is wholly an animal process. Presuming that it is an animal process from the analogies hinted at (which may be adverted to in the gross, by saying that none of the processes which take place during life happen in the same way after death), presuming upon these analogies, it is to be inquired in what way, or what are the agents mutually concerned in the separation and absorption of chyle from the intestines by the operation or concurrence of the properties of life?

§ 8. It may here be urged against the conclusiveness of the above experiment, that after death the area of the absorbents is different from that which obtained during life; and hence a separation of an hydraulic kind may not take place from an altered diameter of the tubes which should perform it. This objection, however, is of no great weight; for we can conceive a fault in the diameter of the tubes to be one of only two kinds, they are either too large or too small. Now it is ascertained in the sanguiferous system, and it is here in consonance with every analogy which can be cited, that the area of vessels is greater during life than after death; that is, both

their powers of contraction are, during life, to a certain degree, overcome by the distending force of the fluids they convey; hence the separation and absorption of chyle proceed under their greatest possible area. And as there are times and cases of inanition, in which absorption does not proceed at all, or but dubiously, so at these times the vessels being left to the operation of their tonic contractile power, will be reduced to a less diameter than after death. Yet will the process of lacteal absorption be resumed, when the material (as in those nearly starved) is again furnished, although their area be reduced to a size less than that to which they would be brought by their elastic power, the only one which operates after death. Hence, if lacteal absorption proceed under the extremes and intermediate degrees of area of which these tubes are capable, and after death does not proceed under a degree which during life was shewn to be compatible with the process, the want of absorption in the former case, and the occurence of it in the latter, must be attributable to something more than a dependence upon the caliber of the vessels. This reasoning in part proceeds upon the *assumption of an analogy* between the contractilities of the mesenteric absorbents and those of the arteries.

§ 9. The question would be in a great measure decided by the result of such an investigation. But presuming upon the analogies before mentioned, that the absorption of fluids by the lacteals is a process in great measure, if not wholly, functional, the laws of the function are to be investigated principally with a view to the settlement of the following points:

1st, By what is the function of the lacteal orifices constituted? This question must be answered (if the function is one belonging necessarily to a living structure) by properties of life, with the concurrence of a structure of certain mechanical arrangement, and made up of chymical constituents.

2nd, What are the properties of life engaged in this function? We cannot define them: we may say that they are peculiar, or involve, or are connected with the common ones, viz. with those which prevent decomposition of the textures; but how they are connected with these we are not yet to consider.

3rd, What share in the function is to be attributed to the vital properties, and what to the mechanical and chymical constitution? This is an inquiry into dependences on which a short sketch must suffice. If the absorption does not take place without life, then it is dependent upon life; but there is no example of a process of any kind which is confessedly dependent upon life, taking place without also the aid of the textures. Here, in perhaps most other instances, analysis must stop; but in this we may proceed a little further: as observed in the article "Relations of Vital, Chymical, and Mechanical Properties," mechanical construction is directly related only with mechanical phenomena. The spiritual and chymical agencies have been said to be directly related with each other, and to be intermixed. We are under the necessity of supposing this, because we remark the perpetual changes which are mutually operated in these

departments; we find that the most powerful agents which affect the spirit are of the chymical kind; we know how life and its processes are modified by them; and we see them, as in the cases of poisons, producing its extinction, &c. But although from their alliance we consider these properties as *chymical*, yet may they (the efficient ones) be wholly *vital*, and not those by which the phenomena of the laboratory are accomplished. My meaning may be illustrated by a supposed example. Thus, death may be occasioned by one of the metallic oxyds: with respect to its chymical nature, it is an oxygenated metal which kills; but it may possess properties related with life, which do not belong to the metal or to the oxygen, but which are allied or associated with them, and having their relation only with *vital* properties, are inefficient in regard to the chymical ones: that is, the chymical substances may be related with those of their own kind, which are met with in the laboratory; and their vital associated properties also with those of their own kind, which are met with in living bodies, and perhaps in spontaneous formations approaching to life. This, however, is a refinement merely consistent with the doctrines of causation, and not worthy of attention in the present state of analytical research, which is yet to be employed upon grosser matters. To return from this digression: the supposition of a mechanical agency in this business of lacteal separation and absorption is, on the grounds referred to, dismissed. With regard to the chymical, we observe that the agents of chymistry are generally of the material kind; hence we have difficulty in distinguishing their share in phenomena occurring by means of the secretions, but not in places where secretions do not take place; and as the absorbent, in some respects stands contra-distinguished to the secerning, extremities, so on this ground the supposition of a chymical agency can scarcely be indulged. According then to this view, at least the principal agency in the business we are considering appears of the spiritual kind.

4th, Are the *separation* of lacteal fluid from intestinal chyle and its absorption to be considered as the result of one process, or are they accomplished by the same properties? We can answer this question only by remarking, that the absorbents elsewhere shew a capability of absorbing almost any substances which are fairly submitted to their action; and that when, as in the present case, they take only, from among many, one fluid, which rarely digresses from a pretty uniform character, the exception must be attributed to some peculiarity, to the operation of properties which do not obtain generally in the absorbent system. Whether these modifying properties, those which make this example of absorption peculiar, are those upon which also depend the separation of lacteal fluid from the intestinal material, is more than can be decided, or even conjectured upon with any great shew of truth, in the present state of our evidences.

5th, Is lacteal fluid a mere separation? or is it a new constitution made up by a combination of properties from absorbent orifices

with related properties, and, conjoined with them, mediately-related substances, belonging to intestinal chyle? As the properties referred to are of the spiritual kind, analysis cannot reply to this question; which must therefore remain a question, on which perhaps a few words might be said when we speak of secretion and absorption in general.

6th, Do any changes happen to the lacteal fluid, in the course of its transmission from the lacteal orifices to the left subclavian vein? Do any changes occur in consequence of a function possessed by the tubes themselves, or by their glands? There is, I believe, no proof of such changes. The sensible appearance of the fluid is throughout pretty nearly the same. With respect to a supposed function belonging to the mesenteric glands, some remarks might be cited from our pathological experience; these however will have but little weight. It may be said, that if these glands are obstructed, nutrition will be impeded: this proves only that a mechanical fitness of the structure, a pervious state of the vessels, is necessary for the transmission of their contents. It will be said, too, that in *old age* the glands of the mesentery are almost entirely removed: old age is sometimes attended with a *diminution*, and sometimes with an *increase* of bulk.* These facts, therefore, so far as they may be allowed to favour any conclusion, seem to indicate that the tubes and glands of the lacteal system have no function or use, in addition to that which they possess as a mechanical structure. This opinion derives its principal credit from the circumstance that whatever variety the tubes and glands of the mesentery might suffer from disease, the variety affects only the quantity of fluid transmitted to the sanguiferous system, while the quality and appearance of the fluid have not been observed to suffer any alteration which might be imputed to a disordered function. If I were inclined to conjecture upon the use of absorbent glands, as one might conjecture, *in infinitum*, upon things where the evidence is of the most dubious and insignificant kind, I say if I were disposed to do this, I could add but very few conjectures to those worthless ones which have been already proposed upon this subject—which is as well left alone.

7th, As it may be said to have been shewn that the *separation* and *absorption* of lacteal fluid is probably accomplished by the spiritual properties of the structure, or by its life; the nature of this life, or the history of these properties, is next to be inquired after: here there is little to be done but to recur to a leading division which has been proposed with respect to the other organs. It is to be inquired, is the assimilating, also the functional life of the lacteals? or, is the latter of the regular dependent, or of the occasional kind? The choice lies between the two former, and the only clue for the investigation is that before mentioned to have been adopted in some

* Is such spontaneous removal of the glandular structure of the absorbents attended with an *obliteration* of the absorbent vessels, which before passed through it, or is the continuity of permeable absorbent tubes preserved amidst the absorption of connected structure?

other instances with success, consisting in a division of the nerves which supply this structure, and an observation of the results of this division, in regard to the separation and absorption of lacteal chyle.

§ 10. The processes by which the ends of this function are accomplished may be inquired into with much greater minuteness. There is hope, however, of adding but little that is valuable, by such inquiry, to the information which is already attained upon the subject. This information respects the final purpose of the function. It may be said, in the way of a summary, that the vital properties of the lacteal orifices are, with the concurrence of their structure, so related with the contents of the intestines, that a fluid of a certain character is separated, or formed from the general mass: that this fluid is conveyed in a way, of which we shall hereafter say a few words, through the absorbent vessels and glands into the sanguiferous system; that the fluid thus conveyed is necessary to nutrition; and that the function of the lacteals is thus *mediately* related with the diffused life and textures, there being no evidence of a relation of the *direct* kind, or one by which the results of a functional life, or occasional phenomena, are produced, as by a communication of properties with a related seat. The only way in which the lacteal system may be supposed to be *directly* related with another seat is that of a possible dependence for properties received; of which enough has been already said.

§ 11. At this place we may say, that the enumeration of one system of preparatory organs is ended. It has been sketched what are the principal points of investigation belonging to these organs: these points might have been much more minutely particularized; but the design of these articles is to exhibit a general view of relations which are to be taken into the account, though most commonly overlooked, in an inquiry concerning the operations which concur to maintain a living body. It is not attempted to give a complete explanation of any single process; each process must be the object of a specific and undivided investigation. Such particular investigations abound in the records of physiology, but they have not embraced the whole of the topics which belong to them. Some have thought to explain the physiology of these organs by a minute delineation of their anatomical structure; others have applied chymistry to the same end: both have failed totally. Others have considered the principle of life as the secret agent in all these processes. But none have considered these three as they are related with each other; much less has any one attempted an analysis of the last, by which any leading laws, or classification, may be assigned to it: and still more remote has it been from the designings of physiologists to evince that life, as an agent, operates, and is acted upon, in a manner which is common to every possible form of existence. This matter will however hereafter require a general recapitulation.

§ 12. The organs enumerated in this section appear to form one system: the division here adopted may be artificial, but it is convenient. It is founded upon an apparent concurrence of their several functions to produce lacteal chyle, and to convey it into the system of the blood-vessels. The accomplishment of this purpose constitutes that which is termed nutrition. The further history of this lacteal fluid will shew that there is no part of the body, no process in it, we may say no property of it, which does not acknowledge a dependence upon this nutrient material. Hence the organs which produce it are thus mediately related with all other parts: the relations subsisting among themselves, and tributary to this one purpose, still afford an ample field for research and discovery. Lacteal chyle being poured into the sanguiferous system, its future history will commence from this point, and will be involved in the phenomena dependent upon the blood.

SECTION III.

RELATIONS OF BLOOD, AND ITS PRODUCTS, IN ITS VESSELS, AND IN THE SEVERAL PLACES OF ITS DISTRIBUTION.

CHAP. I.—*Formation of Blood.*

§ 1. BLOOD is a conversion of chyle, or another change in the preparation of that fluid furnished originally by food, and traced through the processes of digestion, &c. We have found it no difficult matter to specify the seats of certain conversions which take place in the alimentary canal: it will not be found so easy to assign the seat of conversion of lacteal chyle into blood; this, however, is our present business.

§ 2. To pursue the question analytically, according to rules of causation, would embrace an investigation with respect to the following objects: 1st, it is to be determined whether blood has properties communicated to it, which properties are not possessed by chyle; or, 2nd, whether chyle is made blood by a separation or abstraction of some of its properties; 3rd, whether these modes of causation both take place; and, 4th, what are those properties which constitute the difference, whether foreign ones superadded to chyle, or deficient ones abstracted from chyle, and by such abstraction admitting the condition of blood? 5th, is blood made by a single conversion of chyle in the sanguiferous system, or many conversions? if the latter, the comparative changes are to be investigated with the above objects and the properties engaged, specified; 6th, the causation is to be proved by the analytical and synthetical tests; 7th, the seats of individual conversions or changes, with the history belonging to each, are to be respectively developed and assigned. An investigation, according to this method and with these views, is to be hoped for in the progress of science: it

must be specific and undivided; the several objects and their connexions must never be lost sight of; in the conduct of it there must not be one superfluous design, and in the detail of its results not one superfluous sentence. This is a project, I fear, for the next age: we must for the present, at least in this place, be content to proceed more loosely, without however wholly losing sight of these indications for an analysis.

§ 3. Lacteal chyle being poured into the sanguiferous system, of course becomes red by its mixture with blood; but a *source* of its colorification is necessary, 1st, because the present red blood is changed, or other blood substituted for it from the lacteal fluid, in the lapse of time; and, 2nd, because, although a white fluid may have its colour changed by mixture with a red one, this mode could not obtain before the red fluid was formed, viz. in the first periods of the ovum; or, as best exemplified in the stages of incubation. Some *source* of the colour therefore is necessary.

§ 4. The change of colour is the most obvious one which chyle undergoes: perhaps in real utility it might be subordinate, or probably altogether unimportant. Whether this change is only a concomitant with others, and what those others are, can be determined only by our comparative analysis. The seats of those other changes are to be sought after when the changes can be specified; for the present, we may take the obvious one of colour, as a clue to the investigation of the associated changes which we have supposed.

§ 5. If it is inquired generally what is the seat of the conversion of chyle into blood? it must be replied, as generally, the seat of it is in the vascular system, where it is observed to occur; but a more particular question would require us to specify in *what* blood-vessels, or in *what* structure of their distribution, or is the faculty of the conversion common to all?

§ 6. The general opinion seems to be that arterial blood is made in the lungs; that venous blood is a product connected with a function either of the arterial capillary terminations, or of the minute origin of the veins.

CHAP. II.—*The Lungs.*

§ 1. THAT the seat of the conversion of venous into arterial blood is in the lungs, is very evident: it is quite another matter to affirm that the lungs constitute the seat of the conversion of *chyle* into *arterial blood.* If we seek here for proofs, we shall not find them. To proceed, however,

§ 2. Chyle, it is said, or if not said is currently imagined, is made blood in the lungs. What are the grounds of the inference? Why, it will be observed, we see that the colour of the blood carried into the lungs by the pulmonary artery is different from that which is returned to the heart by the pulmonary veins. This fact relates to the changes of *blood,* not to those of chyle. Is there no better proof?

§ 3. The function of the lungs, it is said, consists in an exposure of blood to the influence of atmospheric air, by which it becomes oxygenated. Now, then, imitate this function with respect to lacteal chyle, expose it to atmospheric air, and see if it will be converted into blood; the experiment is easy. It is converted into nothing, in point of colour, like blood, either arterial or venous. The lacteal chyle is nearly white, its colour is not immediately changed by exposure to air: by a continued exposure it becomes a little darker; but still its colour cannot, without a great stretch of the imagination, be fancied to resemble distantly that of arterial blood. It remains to be known whether any of those differences between chyle and blood, which chymists have either discovered or fancied, occur on the exposure of chyle to atmospherical air.

§ 4. From the above fact, viz. that lacteal chyle is not made blood by exposure to atmospheric air, one of two inferences must be deduced; either that the conversion we are considering does not take place in the lungs, or that, if it does take place in the lungs, these organs possess a function independent of, or superadded to, the influence by atmospherical air. These alternatives will require a short discussion.

§ 5. We are furnished by nature with no *proofs* derived from the observance of the phenomena of health or of those of disease, that the conversion of chyle into blood takes place in the lungs. If therefore we require proofs upon this point, they must be sought after experimentally.

§ 6. There is only one experiment which can apply to this question; it is by observing whether chyle, thrown into the vessels of the lungs, is made blood. Thus far the experiment is practicable: but but there would be absurdity in attempting it, 1st, because in the living organs the blood in the pulmonary vessels would be fluid, the chyle would mix with this blood, and the design of the experiment would thus be frustrated; 2nd, because if the blood were not fluid, or if it were in part coagulated, then chyle would in some degree mix with it, and receive a tinge from its colouring matter; and, 3rd, because the lung in this state would be deprived of its life; a circumstance sufficiently important to invalidate any inference which might be founded upon an assumed analogy between the natural and the artificial process.

§ 7. We are then, it appears, furnished with no proofs, either natural or from the resources of art, by which the seat of the conversion of chyle into blood may be shewn to be in the lungs. As we cannot obtain proofs with respect to this conversion, we must seek for evidence of a weaker kind.

§ 8. The conversion takes place somewhere in the sanguiferous system: is it by a property possessed by the blood-vessels themselves? There is, it must be replied again, no proof of the existence of such a property; neither is there any experiment which would decide the question, unless it be one by which the mixture of chyle with ready formed blood would be prevented. This may be done by enclosing a certain space of an artery of a living subject between two ligatures, and injecting this portion with chyle; but if the conversion did not occur in this space, it could scarcely, on this account, be inferred that the arteries do not possess the properties by which the conversion is effected, as the action of the ligatures may intercept a spiritual intercourse, upon which such a function may depend. However, the evidence furnished by the result of such an experiment is liable only to the general objection that the natural function of a part is to be inferred suspiciously from experiments which place it in a preternatural condition, and thereby destroy the analogy upon which the inference is founded. This latter is the point to be attended to in experimenting: and, in the present case, to decide whether the operation of the ligatures interfere with those points of analogy which affect the inference, would require another investigation.

§ 9. There is only one obvious change which takes place in the lungs, and that is the conversion of venous into arterial blood. This change appears to be wholly atmospherical, as a similar one is found to occur in venous blood, when exposed to the air, removed from any influence of the properties of the living structures. This is a change upon which chymistry has been busily employed; and, as is usual with chymical investigations, applied to animal phenomena, just so much has been ascertained as is not worth knowing.

§ 10. The seats of the other conversions of the circulating fluids may be fixed with some precision, because it may be observed where, in what order of vessels, in what viscus, these changes occur.

With respect to the conversion of chyle into blood, the scope of its seat is no less ample than the whole vascular system. These additional questions arise upon it: 1st, is the conversion produced by a relation which chyle has with the properties of the arteries? or, 2nd, is it by a relation with properties of the veins? or, 3rd, is it by a relation with properties of the lungs, superadded to their atmospherical function? or, 4th, is it by a relation with the secerning extremities of the arteries? or, 5th, if with these extremities, is it common to all, or does it belong only to those of a particular seat? or, 6th, is there any other viscus in which the conversion takes place? or, 7th, is the conversion of chyle into blood an effect produced in no single seat, in no one order of vessels, but a result of all the processes which occur in the vascular system? and, 8th, if not the result of all, but of some or many of the processes, what are the seats of those processes, and of what kind are they? This latter question will admit the application of the analysis which has been many times sketched.

§ 11. Until it shall be shewn that the conversion of chyle into blood takes place in the lungs, there is nothing more to be said of these organs; there being no proof that they possess any function in addition to that of converting venous into arterial blood. Yet, even in this simple matter, there is something for the chymists to settle, the minute inquiry into which might furnish those proofs which we have just said were wanting. We require to be informed satisfactorily, whether the same integral changes occur in blood removed from the body as those which take place in the lungs. To answer this, they must extend their analyses: whether the same gases are evolved? whether the same are imbibed? whether the same constitution succeeds among the other components of blood, *i.e.* whether the constituent properties of blood will preserve in every respect the same relations? whether the exhalations are of a similar quality? From the results of inquiry upon these topics (which may be still further multipled) it is to be inferred whether the relation of blood in the lungs is wholly of the atmospherical kind. If it is not, then the properties of life come to be considered, as whether of the assimilating, or of the regular dependent, or of the occasional kind, in agreement with those indications for an analysis which have been before mentioned.

§ 12. The mechanical phenomena of respiration have been investigated with more success than those which respect some other relations of life. The lungs are considered as passive in the acts of respiration. Their soft and cellular texture is compressed by the diaphragm, &c. and the air thus forced out of them, the capacity of the thorax being at this time diminished: this is the act of expiration. In inspiration, the air enters the cells of the lungs, the diaphragm sinks, and the capacity of the chest is increased: these acts are alternated, and they constitute mechanical respiration. Thus far the matter is very clear. Yet though the supposition is tolerably current that little or nothing remains to be added to our information respecting this process (its dependence upon the brain

through the medium of the nerves having been ascertained), yet I suspect there are some points which have either not been thought upon or are at least not determined, and may therefore be proposed as questions.

1st, Is the descent of the diaphragm in the first and subsequent inspirations mechanical? that is, does the pressure of the air cause it to descend, or does it descend by an inverted contraction of those fibres which produce its ascent? or,

2nd, Are these two acts, viz. inspiration and expiration, produced by the contraction of two sets of muscular fibres? The most obvious solution of this matter seems to be, that the fibres of the diaphragm contract only in the act of expiration, that their power of contraction is spent by each exertion of it, and that having contracted their full sphere, the resistance to the pressure of the air ceases, and this medium entering the lungs, distends them and depresses the passive diaphragm, which having attained a certain point, re-acts and expels the air. Thus far the theory: then, arising out of it, it is to be asked,

3rd, What share has the pressure of the air or the distension of the lungs in producing a contractile movement of the muscular fibres? It will be pertly answered to this question, the stimulus of pressure or distention causes the diaphragm to contract. Let it then be called a stimulus, since we must designate the agent by some name.

4th, What then is the relation of this stimulus with the power of contraction? is there a property belonging to pressure or distention, directly related with the animal properties of the structure? or is the relation mediate; that is, by the intervention of mechanical properties of the texture, related with the vital ones? These points settled, it remains to be determined concerning the relations by which the act of contraction is constituted; as,

5th, Whether the properties related with this stimulus of distention, and concurring with it to produce the contraction, live by assimilation in the structure of the respiratory muscles? or whether they are obtained from a distant source? The latter appears to have been ascertained by the results of the division of nerves, &c. This conclusion admitted,

6th, Are those properties of the respiratory muscles derived from a distant source, regularly and unremittingly communicated while the nerves are unimpaired? or are they of the occasional kind, that is, produced in the muscles by a process of the following order: 1. Foreign properties (the stimulus of distention) related with and producing change of the inherent ones of the muscles. 2. This changed condition of the inherent muscular properties related with others belonging to the nervous centres. 3. Effect of this relation, that properties from the centre (under this process) are communicated to the distant muscles. 4. Conjoint result of all these properties, a contraction of the muscular fibres? These questions belonging to mechanical respiration, are here merely suggested,

their discussion will belong more properly to the subject of *animal life*, and to that part of it which relates to the laws of muscular motion.

§ 13. The probable mode in which the oxygenation of blood in the lungs takes place, may be thus briefly described: during *expiration*, capillaries which communicate with the air-cells imitate the process of secretion, or else merely exhale an aqueous vapour; during *inpiration*, these capillary, or exhalent, vessels become filled with air, and by continuity of tubes convey air, or certain properties of it, to the blood.

CHAP. III.—*Arterial Blood.*

§ 1. IT has not been presumed to assign the seat of the conversion of chyle into blood: but the conversion of venous into arterial blood takes place in the lungs. It has been suggested, in speaking of these organs, that the obvious changes, as that of colour, &c. may not be the most important ones. Although the exposure of venous blood to the air, by which, as they say, it is oxygenated, is a thing necessary to the support of life; yet the mode, or process by which it becomes necessary to life has not been minutely investigated. The change which takes place in the blood in its passage through the lungs is one interesting chiefly the vital properties of this fluid, it is a preparation of the blood for future purposes. We know in the gross that the admission of air into the lungs is requisite to this preparation; but that the preparation consists in the mere oxygenation of blood is more than we have a right to conclude. Such an inference can be sanctioned only by facts which shew that blood exposed to air and oxygenated in any other seat is capable of maintaining life. We know no such facts, and until they are attained we have a right to suspect that the vital properties of the structure have a relation with those of the blood and contribute towards its preparation in this stage; and that the change which blood suffers in the lungs is one produced by the complex relations of blood, air, and the properties of the structure: for it must be remembered that although earth and air have been said to contain informal life, and to furnish the elements of constituted life, yet these sources are modified by the living form in every variety of animal existence, and, so far as we can trace the matter perceptibly, in every stage of their relation with each. If we could not satisfy ourselves by observation to the contrary, we may as well suppose that food containing its share of the elements of life is diffused among the structures which are the seats of it, without the previous changes elaborated by the vital properties of those which have been termed the preparatory organs, as that air, mixing with blood, is at once fitted for all the future purposes of this fluid, without any concurrence in its adaptation of the vital properties of the organs into which it is first received. At least we are justified by analogy in this suspicion in the absence of proofs on either side, the want of which we are still likely to lament, as our analyses do not reach the order or constitution of spiritual change.

§ 2. It is proved by the results of intercepting the supply of arterial blood to the structures that the life of these parts cannot be supported without it. In some instances this is shewn by direct experiment, as by ligatures upon the arterial trunks through which blood is conveyed to the seat which might be the subject of the observation. In other instances which have never been subjected to this test, the necessity of arterial blood to the support of life is inferred agreeably with the results just hinted at.

§ 3. Unless the tendons, &c. form exceptions, there is no structure which is not composed of tubuli, communicating with the arteries. But the extremities or minute communications differ in many respects from the trunks: hence, as the continuity of a vascular system is extended, the tubes composing it are arranged into several orders, exercise different functions, hold different relations, and exhibit phenomena peculiar to each. That all structures are composed of tubuli continuous with the arteries is inferred on these grounds: 1st, that the life of the parts in question would not be preserved if this continuity were interrupted; 2nd, that all parts display the phenomena of growth, and require the processes of nutrition; 3rd, that all parts are permeated by fluids, all of which results are dependent upon the supply of blood. If any parts are nourished by porous absorption, the argument is not by such fact invalidated, as it is of no consequence whether the fluids pass into such parts through an uninterrupted tube, or whether by proximity of the openings into vessels, or by the arrangement of an intervening structure performing the office of an uninterrupted tube, by an intermediate channel. The communication of the component tubuli of every structure with the arteries is preserved, and this is all I now stipulate for.

CHAP. IV.—*Relation of Blood with the Heart.*

§ 1. THE heart possesses the assimilating and the functional life. In this, as in other instances, the assimilating life maintains itself, and is proper, or belonging to this place or structure: the functional, accomplishes those phenomena which are *peculiar* to the organ, and superadded to the common properties of life. The objects of a full investigation of the physiology of this organ would be comprised in a history of the changes of its principle and structure, from the state of the maternal ovum till it has attained a fixed and perfect constitution, when its phenomena and relations are to be specified, and their dependences inquired into.

§ 2. The principal questions here to be discussed are,

1st, Are the assimilating and functional properties of the heart distinct or identical?

2nd, What are the relations of blood in the cavities of the heart, with respect to the above properties?

§ 3. 1. The first question is to be determined by facts which prove whether any of the properties concerned in the action, &c. of the heart would cease if the connexion of this with other parts were intercepted. It is difficult to experiment upon this subject with satisfactory results: a short view, however, of the state of the question may here be admitted.

§ 4. The nerves of the heart, it is said, may be divided, and the heart will continue to contract and dilate: hence it is inferred, that the action of the heart is independent of the nervous centres; or, in other words, that its properties are all inherent, or maintained in its own structure. But the facts are too imperfect to justify this inference, as the heart possesses a power of acting *for a time* under a privation of an ascertained cause, and a necessary one to the permanence of its action, viz. after the circulation of blood has ceased.

§ 5. On the other side of the question, it is urged, the power of action of the heart is destroyed by an *injury*, or breaking down of the structure of the medulla spinalis. A dependence is inferred from this fact, but with less propriety than from the last; for it has been shewn that the simplest mode of intercepting a communication, as by division, &c. is in some degree liable to the suspicion that the remote change takes place by an influence, or properties, conferred, foreign ones; and certainly in no case will the *injury* of one part

prove, by an affection of a distant seat, that the latter ever acknowledged, with respect to the former, a dependence as for properties habitually, or even occasionally *received* in the condition of health. Hence, the facts which have been quoted to prove either the inherent muscular power of the heart, or the remote dependence of this power, are alike inadequate. I say nothing about the idle experiments made on the heart by galvanism, electricity, &c. which are scarcely worthy to form an amusement for a school-boy. Those also who have sought for analogical proofs from frogs, toads, and fishes, had very little more wit than the subjects of their experiments. The multiplication of useless facts, and of those which are irrelevant to important conclusions, tend rather to impede, than to promote the progress of science.

§ 6. There are then no facts which prove whether all the properties of the heart are assimilated in this seat, or whether some of them are derived from another, and superadded to the assimilating ones. The voice of analogy must here also be silent. We have ascertained a certain dependence of the voluntary muscles on the nervous centres; but we cannot transfer this fact to the heart. We are told that some secretions, as the gastric, &c. are suspended by a division of the eighth pair of nerves; yet we know that other secretions, as those of lymph, pus, &c. will proceed in the arm, which is paralyzed, or in the leg of an animal after a division of the axillary plexus. In short, we cannot decide the point by a just reasoning on the facts we possess; and therefore, as with all other doubtful matters, it is best to acknowledge it undecided.

§ 7. 2. The relations of blood in the cavities of the heart may be considered, 1st, with respect to the vital properties of the organ; 2nd, with respect to its material structure.

§ 8. That the motions of the heart are not dependent upon the quality of the blood contained in its cavities appears to be proved by the fact, that either ventricle will contract upon venous or arterial blood. And that the motions of the ventricles are not dependent upon the volume of blood, or produced by a repeated distention, appears to be deducible from the fact that the movements of contraction and dilatation continue when the circulation has ceased. Hence, the blood in the ventricles appears to contribute nothing essential to the function of the heart. A strict and minute inquiry may perhaps indicate that the movements of the heart are liable to be affected by varieties in the *volume* of blood in its cavities: this, indeed, we may pretty reasonably infer from analogy. But the fact, if admitted as one, is very short of proving an habitual dependence of the action of the heart, upon a fluid which is poured into it, rather to suffer, than to act.

§ 9. If the blood in the cavities of the heart is not necessary to the function of this organ, what are we to say of its relation with its assimilating life? Does the blood in the ventricles maintain this organic spirit, or is it assimilated from the vessels which ramify in its structure? We observe that the functional properties never sur-

vive the common or assimilating ones: hence, if the former continue when blood ceases to be poured into the ventricles, we must infer that the latter also are not extinct; and that if it is allowable to conclude the functional properties independently of the volume, &c. of blood, it is, by parity of reasoning, allowable to infer of the common ones a similar independence. But the truth is, that a positive inference is justified in neither case; for, as the heart continues its motions after the circulation has ceased, or after all the blood has been abstracted, so if these motions are admitted to prove that the powers of the heart are independent of the presence of blood in the ventricles, they must also be allowed to prove that its powers are independent of the blood altogether, whether in the ventricles or in the coronary arteries, which is not the fact.

§ 10. We are here (as in the case where the independence of the heart of the nervous centres is inferred from the results of the division of its nerves) brought back to the conclusion that the heart retains its life, or is endowed with a certain quantum of it; or rather that its assimilation is peculiar, by which its phenomena continue to be exhibited under an absence of the regular circumstances which are essential to its permanent action.*

§ 11. As then there is no small disagreement, or rather confusion, among the facts already noticed; and as the facts, if less confused, are generally of a kind so loose and distant as hardly to apply with correctness to any argument for which they have been cited; we must on these accounts seek for evidence from some other quarter, and of another kind.

§ 12. I have seen it somewhere stated that the heart is paralyzed by ligature on the coronaries. This fact, if it is one, appears at first sight to be conclusive in regard to the source of the heart's assimilation, &c. It is however liable to these objections: 1st, that the *injury* inflicted might destroy, by communication, the function of the heart; 2nd, supposing this not to be the case, and that the function depends upon the blood in the coronaries, as upon a source; a similar dependence cannot be inferred with respect to the assimilating life, because this latter would cease from a cessation of functional operations, without any dependence upon that cause, the privation of which renders the muscular properties of the heart extinct. This circumstance also remains to be reconciled with the fact that the heart will continue to act after the circulation has ceased, or even when removed from the body. To extend therefore a little further the discussion,

§ 13. Venous blood, it is pretty well known, will not maintain life; that is, the spirit cannot assimilate or produce itself from venous blood. As none but venous blood circulates through the right cavities of the heart, it is to be inferred, in consonance or analogy

* It is possible that this peculiarity may consist in a power of assimilation both of the common and the functional properties, from the blood which pervades the structure of the heart, although it may be in a state of rest; and that this assimilation proceeds, as long as this blood contains elementary life,

with the fact just mentioned, that the life of this side of the heart is not maintained by the blood in the ventricle, &c.; and although arterial blood passes through the left cavities of the heart, it is to be inferred, from the resemblance of their structure to that of the right side, that there is another source of the elements of life besides the blood in the ventricles: in other words, that the blood from which the life of the heart is assimilated is not that which is contained in the ventricles, but that which circulates in vessels of another order. It will be suggested that the conclusion is further supported by the fact, that, in asphyxia, the circulation is continued a short time after the office of the lungs is prevented. The evidence however of this fact appears to lose its force when we recollect that the action of the heart will continue for a time, when the circulation (an acknowledged source of its permanent life and action) has ceased.

§ 14. There are no facts which prove that the pabulum of the structural assimilation of the heart is furnished by the blood in its cavities. The argument of analogy, quoted in the last paragraph, would rather decide against such a supposition; for, if venous blood will not maintain spiritual assimilation, we can scarcely expect that it should produce the structures, the formation of which we know to be dependent upon the life which precedes their growth and preserves their cohesion.

§ 15. To repeat: the two questions proposed, as including the physiology of the life of the heart, and the relation between this organ, and the blood in its cavities, are, 1st, Are the assimilating and functional properties of the heart identical or distinct? 2nd, What are the relations of the blood with the above properties?

§ 16. These questions, agreeably with our discussion, are thus answered: 1st, There is an entire absence of proofs whether the heart is directly dependent upon a related seat for the properties which aid or perform its motions. The action of the heart may be influenced, as every one knows, by affections originating with distant nerves: but this fact proves no regular dependence. 2nd, There are no facts which prove either that the functional or common spiritual properties of the heart are renewed from the blood in its cavities. At the same time there is reason to believe that the action of the heart may be affected by the quantity of the blood in its ventricles, &c.: this will be supposed in agreement with many analogies. We are, in this case, precluded the analytical test of dependence, because the blood cannot be excluded the ventricles without a cessation of the circulation; and any inference which might be made from the observation of phenomena under such circumstances would be equally, and perhaps more justly, attributed to the absence of blood in the coronary arteries.

§ 17. The strongest facts which relate to the physiology of the heart are, 1st, the heart continues to act after a division of its nerves: this fact suggests the conclusion that the action of the heart is independent of a nervous centre. 2nd, The heart is paralyzed by tying the coronary arteries: this fact suggests that the life and

functional properties of the heart are assimilated from the blood which is distributed by these vessels. 3rd, The action of the heart continues after the blood has been abstracted and the circulation has apparently ceased, or after the heart is removed from the body. The two last facts can be reconciled only by one of the following alternatives: 1st, that the life of the heart may be assimilated from blood in a state of rest, as long as it contains the elements of life; or, 2nd, that, owing to the contiguity of the mouths of the coronaries to the cavities of the heart, blood is forced into these vessels by its contractions; and that a slow or imperfect circulation is locally maintained in the heart, although it has ceased elsewhere, and finally ceases in this place also, either because the blood gradually coagulates, or else because the elementary life of a given quantity of blood, which has no source of renovation, becomes exhausted.

§ 18. Although there is no evidence, even of the weakest kind, to shew that the life of the heart does assimilate from the blood in its cavities, there is the evidence of analogy to indicate that such an assimilation does not take place. This evidence arises from a fact, currently received, that the spirit does not assimilate from venous blood; which exclusively flows through the right side of the heart. This conclusion leads us up to a wider view of the relations of blood.

CHAP. V.—*Other Relations of Blood.*

§ 1. THE principal objects of blood are, 1st, to furnish the elements of the spirit; and, 2nd, to furnish the elements of the structures. The other relations, as secretion, &c. being tributary to these ends, are so far subordinate, and will be afterwards spoken of.

§ 2. The proof that life is maintained by that which is called arterial blood is, that death quickly follows the interruption of the process by which venous is converted into arterial blood. This fact is sufficiently conclusive upon a question of the necessity of arterial blood to the maintenance of life; but it is not altogether so conclusive, as to the mode by which life becomes generally extinct in consequence of suffocation. The alternatives are, 1st, that arterial blood is required every where for the diffused assimilation of the spirit; or, 2nd, that it is required by one organ, upon the function or relations of which the diffused spirit is dependent. But as the diffused spirit has been shewn to live by assimilation, so it is impossible that such a principle should have any regular dependence for assimilating properties, which, if originally derived from a distant source, are, by their capability to assimilate, rendered independent of that source. Hence, as the second alternative appears to be without foundation, or incompatible with other proofs, and no other suggesting itself, we may venture to admit the first, viz. that the assimilating life, which is the regular organic spirit of every part, preserves itself by uniting its elements, which are informal, in arterial blood.

§ 3. That the blood circulating in the arteries, although of the kind proper for the purpose, is not that which maintains the life of the artery, seems to be evinced by the fact, that a portion of an artery, intercepted by ligature, through which blood ceases to flow, preserves its life; it contracts, and finally becomes almost ligamentous; but if its life were extinct, its decomposition would ensue.

§ 4. If, then, the blood in those arteries which have been the subjects of the observation does not maintain their life, it is next to be inquired whether the blood in the smallest arteries is that from which their spirit is renewed? If it were permitted to decide this question by analogy, we should say, that as the texture of these vessels is very similar, as the blood moves through them with considerable velocity, and as no material difference is remarked between

them, except that of size, on which we can scarcely presume, we should, from these points of similitude, be inclined to reply, that the assimilation of the spirit belonging to the arterial tubes does not take place from the blood which flows through them. But as this analogy, confessedly, is not quite perfect, we will attempt to decide the question of the seat of assimilation by viewing the matter on other grounds.

§ 5. The component structures of the body may be said, in the gross, to be tubular, fibrous, or consisting of particles, held together by some power of cohesion: into this last, perhaps, the fabric of both the others might be ultimately resolved. Of these, the vascular system is an example of the first; the muscular structure, of the second; the osseous (with some equivocal exceptions), of the third.

§ 6. As we found reason to believe that the heart is not nourished by the blood in its cavities, but by that supplied to it by the coronary arteries, so it is currently said that the *arteries* also have their nutrient vessels, and that they live by the blood furnished to them by the vasa vasorum. The proofs of the existence of these minute vessels are, that the structure of the arteries contains blood, which it can do only by communicating with the arteries; and that their structure may be injected. These proofs, however, are by no means conclusive; though it is scarcely worth while to shew in this place in what they are defective.

§ 7. If an artery is nourished by a minuter order of vessels, by what are these vessels nourished? Will it be replied, by vessels still more minute? this would be rather to strain the imagination. But the existence of these still more minute vessels granted, even they, to be identified as vessels, must have their coats, their internal and their external surfaces, and their intermediate composition of organic particles. If the existence of such tubuli is supposed further than it might be demonstrated, where is the supposition of them to end? In truth, the supposition of tubuli may proceed *in infinitum;* but, happily, it is made obvious that the declension of the area of tubuli has some limit, by the fact that when the smallest tubulus is supposed, the lines of constituent particles, of which its sides are composed, must be less than the tube itself. Hence we come to the inference, that particles are laid down, which are not directly obtained from continuity of tubular cavities.

§ 8. But, independent of this limit to the gradual diminution of tubuli, it is sufficient to assign the existence of tubes, continuous with the arteries, so far as there is evidence of their existence; and it may therefore be said, with the anatomists, arteries *terminate* in secerning extremities, &c.

§ 9. Now the questions to be decided are, whether nutrition takes place from the blood in any order of vessels? or whether it takes place from exuded fluids? or whether from both these sources? We can scarcely hope to decide these questions by an evidence amounting to proof; the argument may, however, be stated as follows:

1st, The life of a large artery is maintained where the circulation of blood through its canal is prevented. Hence, from the similitude subsisting between the arteries, so far as their structure, &c. is capable of being ascertained, it is on this ground of analogy indicated, that the life and nutrition of all orders of these vessels are supported by fluids which do not circulate in their canals.

2nd, That a nutrition of vascular structures takes place from fluids not contained in the blood-vessels, may be positively inferred from the fact mentioned above, viz. that the nutrition of component particles of the minutest tubuli cannot take place directly without exudation from a vascular tube.

3rd, That as an extra-tubular source of nutrition may be said to be a necessary one, so any other mode not supported by testimony of the slightest kind is to be treated as an unfounded conjecture, and in agreement with rules of reasoning rejected; because it is contrary to the analogy furnished by the fact first cited, and because also it differs from the nutrition ascertainable on other grounds, in these respects, 1st, that the blood which circulates in the vessels moves rapidly, while extravasated fluids have only a slow motion, or are nearly at rest; and, 2nd, that the fluids having a nutrient relation with minute particles are extensively, if not universally, products from blood, and not red blood. On these data it appears not too much to assume a general, if not an universal, mode of nutrition, from fluids not contained in blood-vessels.

§ 10. If the material of nutrition is not contained in vessels, identified by their coats, &c. there is only this alternative, viz. that the nutrient fluids are extravasated, or effused from the secerning extremities of the arteries, and that they obtain contact and relation with the particles of the structures by a porous or interstitial absorption.

§ 11. We have traced some stages of the preparation of a fluid whose end is nutrition, or the maintenance of life, and the structures, from its state of food, to its formation into blood. It seems consonant with analogy to suppose, that the secerning extremities of arteries exert a function with respect to blood, which is a further, or an an additional, stage of preparation, for the above object, to those which we have already enumerated.

§ 12. That a preparation of blood which is connected with the above purpose takes place, is proved by the facts before cited; and which will be spoken of again, shewing that the products of secerning extremities are, perhaps, in no instances mere filtrations: but what relations the changes which blood sustains, by the processes of secerning extremities, may have with the purposes their results are destined to fulfil, is a question of more especial and difficult investigation.

§ 13. It may here be urged, that if a bone is scraped it bleeds: and that with such an exudation, as to warrant the supposition that red blood is extravasated, which, it may further be conjec-

tured, has that direct nutrient relation with the structure which has just been assigned to the secerned fluids. But the fact proves only that blood-vessels ramify very minutely in the osseous textures, and that blood escapes in consequence of the abrasion of their coats. I would repeat also, in reply, that the relation of the nutrient fluid is with particles composing the minutest cylinders, to which blood cannot pass by vessels, unless it can be shewn that parts less than possible cylinders may be permeated by cylinders.

§ 14. In agreement with the same views, we find that in the processes of organization, subjected to our inspection, as in the regeneration of parts destroyed by ulceration, or in the union of wounds, the nidus of growth is not blood, but a secretion; that which is called coagulable lymph. Whether this is the common product of secerning extremities for purposes of nutrition, or growth, we can perhaps scarcely affirm; it appears, however, to be exhibited as such under disease, and to accomplish this end as a product of dissimilar structures. Thus I have witnessed the production of a circumscribed fungus, which has been cut off and grown rapidly again, and this growth was preceded visibly by a copious deposition of lymph. That a similar lymph is a precursor to organization in other instances is well known.

§ 15. Upon the collective strength then of these circumstances we may venture to assume that the nutrient fluid is a product of secerning extremities of arteries; that it is perhaps generally this lymph of which we have just spoken, which, containing infinite properties (as all other things do), is formed into the various structures by finding new relations in the spiritual properties of each.

§ 16. If it be granted that the nutrient fluid of the body is such a product of arterial blood, the changes which this blood sustains in consequence of the exertion of a process by which the fluid is produced, may be next considered. It is the business of analysis, or of analysis and synthesis conjointly, to specify what is the constitution of the separated material, and to demonstrate the precise change which arterial blood has suffered. In other words, suppose the fluid separated to be coagulable lymph; this identity of it will be ascertained satisfactorily only by separating coagulated lymph from arterial blood, and observing if the same changes occur as in the separation accomplished by a secerning process; and again, by adding coagulable lymph to the blood, which has suffered secretion, and observing whether its former identity is restored. But these minute acts of the analytical inquiry are much more easily directed than performed. We must now, as formerly, be content to consider grosser circumstances.

§ 17. We observe at about this stage of the circulation, viz. when arterial blood has reached the capillary system, that a great and distinctive change occurs in its appearance and properties: this change is implied in the conversion of arterial into venous blood. The question first to be decided is, where this conversion

occurs, or the seat of it? We can on this question propose only the three following alternatives: 1. the conversion is produced by a function of the extreme arteries; 2. it is produced by one belonging to the origins of the veins; or, 3. it is produced by a function of the secerning extremities of the arteries.

§ 18. 1. That venous blood is not produced from the extreme arteries appears sufficiently obvious from the facts, 1st, that the arteries are no where observed to possess the properties of accomplishing the conversion in question; and, 2nd, that the extreme arteries, so far as they can be traced, contain that blood denominated arterial.

§ 19. 2. That the change is not accomplished in the beginning of veins, it appears warrantable to infer, 1st, from the analogy of the small to the large veins; and, 2nd, from the fact that veins will circulate florid or arterial blood without changing its distinctive properties and appearance; as in the instance of the pulmonary veins.

§ 20. 3. That venous blood is produced by a function of the secerning extremities of the arteries, it appears warrantable to conclude, 1st, from those grounds of rejection of the only other alternatives which suggest themselves; and, 2nd, from the agreement which this supposed fact has with the process of nutrition before expressed. This agreement will appear from the following exhibition of particulars:

§ 21. The material of nutrition, separated from blood by the secerning extremities of the arteries. This material, having many constituents, appears to consist of coagulable lymph, possessing this most obviously; this lymph containing the matters of which the structures are composed; this lymph containing also the oxygen of arterial blood, the relation of which is with the living spirit, or with the process of assimilation; this lymph thus furnishing to the living powers and constitution their elements, said to be contained in, or derived from, earth and air: arterial blood thus deprived of its oxygen which passes with a new medium to the places where its nutrient relations exist, is converted into venous blood.

§ 22. Venous blood also contains lymph, most probably in considerable abundance, as we are informed by analysis, and as we may guess from the appearance of venous blood abstracted in fever or inflammation: but venous blood will not maintain life; for although it might have lymph and all the other material constituents, in being *venous* blood, it is deprived of its oxygen; to say nothing of other properties which, though less obvious, may nevertheless be supposed.

§ 23. The preceding theory of the conversion of arterial into venous blood, is in agreement with all that is either perceptible or inferred upon strong grounds in this stage of the circulation; and, in agreement with the theory itself, it is necessnry to suppose the arrangement of the circulating organs, &c. in the seat of this conversion, to be such as may be briefly illustrated in the following way:

a an extreme artery, *b b* secerning extremities, *c* the commencement of a vein, which carries on that blood, peculiar to this order of structure, and which has been subjected to the function of secerning tubes which immediately precede the venous origins. If the arterial structure is continued further than this point, before it joins a vein, then, to a corresponding extent, the artery carries venous blood, as an artery is known to do in the instance of the pulmonary artery, &c. Whether therefore the venous structure commences immediately where the secerning occurs, or at a short space further than this point, is a matter upon which we cannot satisfy ourselves by observation, and upon which, as it is totally unimportant, we may be allowed to indulge either conjecture.

§ 24. The history of the secerning function of the extremities of arteries is still further to be traced. It is to be inquired, what is the process by which the nutrient fluid, whether oxygenated lymph or any thing else, is produced from arterial blood? We cannot answer this question: we can attempt it with an eye to truth only in the analytical way; and what sort of an analysis can we make of properties whose existence is only inferred from their effects—of those of the spiritual kind, which are not objects of the senses, and which we cannot denominate? We must be satisfied with referring this separation to a vital process; and if we would push our investigation into its laws, it is to be pursued by that mode of examining dependences many times described, with a view to ascertain whether the life engaged in this process is the assimilating, or the regular dependent, &c.

§ 25. The fluid produced by the secerning extremities is conveyed through the extent of their tubes; and then, becoming extravasated, its relation with the maintenance of life and the textures begins. As the minutest particles of the textures cannot be cylindrical, so if it is necessary for their own regeneration that a nutrient fluid should obtain contact with them, this can take place only by interstitial absorption. Such an absorption implies that solid particles do not touch each other, but are separated by the medium of nutrition; or, if their contact is actual, that it subsists only as at a mathematical point. To conceive, however, the process in this way, is perhaps but straining the imagination unnecessarily. Rather than these infinitely minute particles, it may be more convenient to conceive them as distinct molecules of visible bulk connected together, but having irregular interstices, by which a fluid is allowed to pervade their aggregate masses. Thus far we have traced, theoretically indeed, the nutrient material through all its several stages, up to that point which may be said to be its scene of action; or where the maintenance of organic life, &c. begins: our peroration at this stage is thus briefly made: *a nutrient fluid slowly pervades the minutest perceptible molecules of the structures.*

§ 26. Thus the fluid which supports life attains the seat of life. This seat we have hitherto spoken of generally: the minuter view which we are now taking requires that it should be considered more particularly.

§ 27. We have said, generally, that the spirit exists in the textures, and that its distinct constitutions, or those which manifest diversity of properties, have their respective spheres. Is it then, it will be inquired, meant to be affirmed that the properties which we have denominated spiritual (or an aggregate of them which we have called the spirit) occupy space? This question involves the old dispute about materialism. The question whether all things are material, is readily decided, when it shall be understood what we agree to call matter. Matter is commonly agreed to consist of an *assemblage* of properties; and this very necessity of an *assemblage of properties*, to constitute matter, proves that there are existences which are not material, namely, those identical properties individually, by which, collectively, matter is constituted. But if the question whether all things are material, is so readily got rid of, there is another which might be proposed as allied to it which cannot be decided so promptly, viz. Is there any form of existence which is not *extended?* and which, though it wants tangibility, and is not an object of any other sense, does not occupy space? If this question cannot be decided, although I think by a long discussion in conformity with our doctrines of causation it might be decided; if then, I will say, this question cannot be readily decided, we need not regret the difficulty of its decision, so far as respects its connexion with our present subject, for either of the alternatives into which it might be resolved will alike answer the purpose to which it might here be applied. The alternatives are,

1st, That constitutions denominated spiritual may pervade substances and exist in solid particles, or have their sphere in a place filled by matter; or,

2nd, That matter is composed of infinitely divisible particles, which have corresponding infinitely minute interstices; that spiritual properties may occupy partially or wholly the interstices of particles, and thus pervade aggregate masses and become related with every portion of their solid contents without adding any thing to their bulk. It is implied by this supposition that the particles composing solid bodies are not in actual contact. Now though I have said that one of these two alternatives must be adopted, and that either is good enough for my purpose, yet I feel inclined to bestow another paragraph or two, in the way of digression, upon the choice of alternatives.

§ 28. The argument against spiritual existence, as meant to imply the existence of something which has no property of matter, and among others does not occupy space, arises from our having so imperfect an experience of such existences; that is, they are not objects which any one sense is fitted to perceive: such at least is a prevailing assertion. But to me it appears that we may quote

the evidence of the senses in proof of the existence of such properties. Thus, those things which are seen and felt are known to be bodies, and to occupy or fill a place in which no other bodies can exist at the same time: of such bodies we have an experience by two senses, but a third sense will afford us just the same evidence of properties which do not possess the above characters; that is, a third sense is related with properties which we can neither see nor feel, and which, admitting the sufficiency of the eye and touch to distinguish all things visible and tangible, must be allowed to have neither bulk nor solidity, nor to fill a space. Thus *sound* is, according to the test of those senses whose business it is, or which are adapted, to discriminate matter or extended substances; sound, according to this test, must want altogether the characteristics of matter, or extended substance, because it is neither seen nor felt. Thus, also, flavours and odours are properties of which we have an evidence as satisfactory, an experience as unequivocal, as we enjoy with respect to the objects of vision and touch. Yet are flavours and odours not extended, or capable of filling space, according to the testimony of the senses which take account of those things which are extended, and which do fill space.

§ 29. The chief difficulty of admitting the existence of spiritual or purely immaterial existences proceeds from the limited acquaintance we have with them, and from the great familiarity which we hold with their opposites, viz. with matter in all its forms. We have senses which take cognizance of immaterial, as the eye and touch do of material, existences; but the forms which the former are fitted to recognise are those spiritual properties making flavour, odour, sound, &c.; while the two other senses of vision and touch, having a more extensive relation, are fitted to perceive not one or two, but all, the forms of matter, and to witness their operations upon each other. But if we are informed by the senses that there are properties which do not bear the characters of material, we are justified in inferring, when we witness effects produced by causes which are equally destitute of the characters of matter, that the causes producing such effects are of that spiritual kind of which we have some examples furnished by the senses of taste, smell, and hearing; but which are nevertheless not objects of these senses, simply because they constitute neither flavour, odour, nor sound; but agree with these in not being visible or tangible, and, so far as this analogy goes, must be inferred to be of the same kind.

§ 30. But it will be urged, there is a still weightier objection than any which has yet been proposed to the belief of spiritual or not extended existences, viz. that these spiritual agents, as they are called, operate upon matter: solid masses are variously affected by them, &c. which it will be said we cannot conceive to happen without contact, and contact implies a junction of surfaces. That one thing cannot move another without contact is true, or appears to

be true, of the objects which we see or feel, or of matter: but as a difference must be confessed between matter and other properties, of whose reality we have also a sensible testimony, so we cannot deduce an inference from analogy, where we have ascertained diversity; on points where matter and spirit agree, we may found an inference: as, in a mere question of *existence*, which is common to both, from witnessing that no material constitutions arise spontaneously, without a formation, by the causes of which they consist, we infer that causation is equally necessary to spiritual forms; because as both *exist*, this point of analogy justifies the inference so far as the analogy goes.

§ 31. And this reference to causation brings us up to the true solution of the matter. It has been shewn that every identity is made by the combination of differentials, or of causes *separately* different from the effect. Hence if it be asked whether there is any thing which is not solid? we may ask, what makes that property which we call solidity? to which it must be replied, other properties which are different from that of solidity; for if they are not different, then solidity exists *per se*, or has sprung into existence of its own accord, which is as much as to say that it has capabilities, before it is; and is contrary to the standing axiom of *ex nihilo nihil* &c. already sufficiently remarked upon.

§ 32. Some grosser facts might also be urged against this doctrine of universal materialism, or against our second alternative, viz. that infinitely divisible particles, constituting the subtilest fluids, pervade substances by filling infinitely minute interstices of apparently solid masses. Still grosser facts may be urged against this doctrine: as that fluids so subtile as to pass through the most dense, should certainly pass more readily through the more porous substances. Thus, light, which is transmitted through glass, a matter having no perceptible interstices under the most powerful magnifier; light, so readily transmitted by glass, should certainly be transmitted through a stone four inches thick, the texture of which is sufficiently open to permit a filtration of the grosser aqueous fluids.

§ 33. This digression becomes tedious: the case is, that which it has been stated in our preliminary articles; the various causes which are contained in the world, as well those in the smallest sphere as those of one half of the universe, hold, with respect to each other, certain relations by which they combine and make effects, differing from themselves; these causes respectively, of course, retain their existence in this work of causation; but two are different from one, and it is upon the same principle that an effect is different from its causes. Some causes that are combined in masses preserve their identity; that is, they are recognized or not lost in the combination: this is determined by that further relation, before spoken of, which things have with our faculties.

§ 34. It will be seen from the general tendency of this, which I have called a digression, that the first alternative is the one which I am disposed to adopt; and which may be re-stated thus: properties

not occupying space, are joined in existence with those which do occupy space, *and the place of the latter denotes the sphere of the former.* But lest the design of the alternatives should suffer by insisting too positively upon either, so far as respects the present application, let them remain as alternatives, either of which is alike convenient.

§ 35. A nutrient material, of the gross, fluid kind, penetrates the interstices of the component molecules of the structures, and thus obtains a relation with the living spirit, whose sphere is acknowledged in every molecule, and in the conceivable particles composing the molecules, of the fabric of organization.

§ 36. The nutrient fluid, thus obtaining a relation with the organic spirit, a consequence of this relation is, that the elements of life, or its causes (or the informal life) contained in the nutrient fluid, cease to be elementary and become the identical or living spirit. The mode of this conversion has been already explained; it may however in this place be re-stated thus: the elements of life are latent in the nutrient material, they are separated from their previous combinations, and *united,* and thus become life. If it be inquired still more minutely concerning the mode of this instance of causation, it is sufficient to say, such is the relation of the causes concerned; but if it should be required to explain it in terms of analogy, we may say that the effect is accomplished by affinity, in the same manner as fire, by an affinity for its own substance, repeats itself, or produces itself, from those sources in which it exists informally, as in coal, wood, &c. and air. That the process is one of assimilation, and not one in which the living spirit operates only as a cause, which is combined with properties in the nutrient material, is proved, as has been more elaborately said, 1st, by its preserving its identity; 2nd, by the necessity that life should exist in order to its own reproduction; 3rd, if life were produced by the union of differentials, one existing in the structures and the other in the material of nutrition, the former must fail, as the state of life is perpetually passing away or tending to its extinction, and is continued only by a perpetual renewal of the properties engaged in its support.

§ 37. It appears then an unobjectionable solution to say, that the living spirit forms itself by an affinity for its elements. This is true of every form of the living spirit. Every organic life belonging to the most simple or the most complex structures affects its own identity; and thus is the uniformity of character of individuals, as well as the general uniformity of species, preserved, alike in the vegetable and in the animal world.

§ 38. As the living state ceases as soon as the means for its support are withheld, so it is to be concluded that there is no stock of life, that it is not a permanent identity; it lasts as long as the identity of a living or assimilating spirit is preserved, and as long as this spirit is supplied with its constituents. Hence two subjects of investigation are started at this stage, 1st, what effects are produced on related existences, or substances, by the living spirit? 2nd, what

is the nature of the conversion which life suffers in again becoming informal? Our business is with the first, the second question belongs to the consideration of death.

§ 39. The first question leads us to consider the relation between the spirit and the materials of the structures: this subject has been pretty copiously discussed under the title of Growth; it requires, however, to be touched upon again in this view of the relations of blood.

§ 40. The particles composing the textures are aggregated in consequence of a relation subsisting between them and the organic spirit. The particles composing the textures tend of themselves not to aggregation but to separation; it is therefore indicated that the power which first overcomes this, their natural disposition, is the one which retains them in their aggregated state; and hence the power which *produces* their aggregation may be inferred from a knowledge of that which preserves their state of cohesion.

§ 41. The alternatives then, viz. whether aggregation is produced by the living spirit or whether by a causation connected with its return to informal life, may be briefly decided: as the separation of organic particles takes place within a short time after the living spirit has ceased, so their aggregation, upon the grounds here stated, and more fully spoken of in the chapter on Growth, must be accomplished by the properties of the living spirit, and not by those of informal life, which would remain, and persevere in aggregating force, after the form of the living spirit had passed away. The mode of this aggregation is to be further investigated.

§ 42. As the spirit is necessarily renovated by assimilation, so additional quantities of the organic particles might be incessantly laid down; but if these were to remain fixed while the spirit passed away, 1st, they would impede the admission of new quantities of the nutrient material to the minute spheres of life, which would then in such spheres become extinct, which is not the fact; and, 2nd, an endless and enormous increase of bulk would be attained, which also is contrary to fact. There must then, in this business of assimilation and aggregation, be some limit of the latter operation, which we are to investigate, or else some countervailing process, by which growth is restricted, and the material admitted to perpetuate life wherever life exists. The following is a theory by which both these objects would be supposed to be accomplished in the most simple way.

§ 43. It supposes that, as the living spirit is incessantly renovated by new quantities of its elements, and aggregates at the same time new quantities of the structures, so as the living spirit becomes informal, the particles which it has laid down or aggregated must also be removed.

§ 44. Such a piece of causation would exhibit an instance of that simplicity which in the operations of nature we so often meet

with by chance, and admire accordingly; and give Nature credit for it in all her works: to explain it further, spiritual assimilation and material aggregation are thus supposed, both, transient acts. The spirit in a sphere has an affinity with its similitude (elementary) in the nutrient material; by this affinity its proper elements are separated from their fluid medium; these elements, agreeing in peculiarities with the spirit they are to renew, are allied with organic particles; these are such as agree with the elements of the life assimilated, and as life differs almost in every sphere, so a corresponding diversity of the structures prevails. The living spirit assimilates or separates spiritual elements; these allied by affinity with the organic particles; the elements of life no sooner assimilated than they become informal, and the relation between life and the particles allied with the elements ceases, the bond of their relation having ceased. Hence particles in the living state, according to this theory, are not fixed, but withdrawn from the fluid mass in which they are contained, and the power that withdraws, then ceasing to act upon, them, they mix again with the common material, being displaced by new particles which are attached to the sphere of the spirit, or else become the subjects of a new relation, as with the system of the absorbents.

§ 45. The truth of the above description of a minute and inscrutable process is indeed most questionable; it will be argued against, and perhaps justly, thus: it will be urged in the first place that such a perpetual succession of new particles in the spheres occupied by the old ones is not demonstrable; nay, if a raw surface be examined ever so attentively with the microscope, the same substance still appears to the eye, at least nothing like a loco-motion of the minutest spherules of the structure is observable. This is certainly a strong argument. It will be further urged, if the cohesion of the solid particles is dependent upon that precise quantum of the living spirit by which they were aggregated, how comes it that their cohesion endures days, weeks, and in some of the textures months and years, after the living principle has been extinct?

§ 46. These objections, if the argument were strenuously insisted upon, would admit the following replies: to the first it would be answered, the successive deposition and removal relate to infinitely divisible particles, and being thus minute they are not objects of sensible cognizance, even with the aid of a microscope, any more than those interstices or pores in glass through which light passes, &c. To the second it would be answered, that when life becomes extinct, the affinity of aggregation ceases, and the particles already laid down are left to obey the laws of matter, and are not superseded by other particles, which, from their affinity with the sphere of the spirit, would tend to displace the old ones, and occupy their place.

§ 47. But as I am not desirous of supporting a theory by argument, where facts are wanting to give it the only sanction which would entitle it to be received; so I shall be content to

state alternatives, to be at a future time decided upon, when minute research shall have become more familiar than it is at present; for which end the summary I propose will serve as indications.

§ 48. 1. Particles composing the solid structures are withdrawn from the fluid nutrient material; and deposited in the sphere of the spirit, by a property belonging to it, which has been called the affinity of aggregation.

§ 49. 2. The aggregation of solid matter is connected with the process of spiritual assimilation. The mode in which the formation of the structures is connected with the process by which life itself is preserved, may, I am aware, admit a diversity of opinions; in the discussion of which, we should perhaps find that the evidence was inadequate to a settlement of either. Premising this doubt, I have supposed the elements of life in the nutrient fluid to be in alliance with matter, peculiarized by other properties; that, by the affinity subsisting between the living and the elementary spirit, the latter is converted into the former, and the material particles with which the elements were allied, at the same time separated from their other connexions. But I am aware that the spirit may not operate in this way; that a causation of another kind may take place: as, elementary life constituting the properties of certain substances; these elements of life being withdrawn from their combinations and immediately changing their form, may leave, as particles composing structures, those substances with which they were before combined, and which they helped to constitute: or, it may be suggested, in addition, the deposition of organic particles may be an act of life distinct from its own assimilation; it may result, and its extent and instances limited, from uninvestigated relations of the functional, or regular dependent life, &c.

§ 50. 3. The particles laid down and forming the structures either remain permanently where they are deposited, or else are removed, within periods, regulated by their proper laws. That they are not permanently fixed, appears to be indicated by the phenomena of febrile diseases, wherein the bulk of the body is observed to be speedily and greatly reduced, and afterwards its original size to be rapidly restored. And that the particles are fixed for a time seems to be demonstrated by the locality of the same spherules being preserved, when they are viewed under the microscope. The laws then by which particles change or retain their place are to be still further investigated.

§ 51. 4. If particles remain fixed for a time during health, although they may be removed under disease, and replaced on the return of health, then it is to be inferred that new particles are not produced by the assimilation of every new quantum of the elements of life, but that the quantum of life is related with a quantum of the properties of the structures; that if the quantum of life is diminished, as by disease, the quantum of the structures is also diminished, the proper bond of cohesion having ceased; that if,

as after disease has ceased, the quantum of life is increased, or its original one restored, that then the new quantum of life is related with new organic particles, which are produced accordingly, and remain as long as this agreement shall subsist. In this alternative, viz. that particles once laid down continue to preserve their place, an operation is attributed to life, or to another process of causation, to which the common cohesion of matter, and the faculty which life has to prevent putrefaction, are both inadequate; for under disease the particles are unsettled, and the textures waste, thus proving the inadequacy of material cohesion to preserve them; and this takes place without, as we have reason to believe, the occurrence of putrefactive processes.

§ 52. 5. As then it appears probable from this view, and also in agreement I believe with general opinion, that the particles composing the structures are laid down, occupy their places for a period, and are then removed, it remains to be decided whether their removal is permitted,

1st, In consequence of a change in their relation with life, as by the cessation of intercourse or influence between particles which have been for a while laid down, and the properties by which their place was first assigned; or,

2nd, Whether their removal is wholly mechanical, as if worn away by a gradual attrition of the fluids moving on their surfaces and in their interstices; or,

3rd, Whether, after remaining in the places in which they were first deposited, they become subject (by a progressive causation or change in the relations of these complex properties) to another function, viz. to that of the absorbents?

As these alternatives respectively will admit of discussion, and as there is a deficiency of facts by which the questions may be settled; or if such facts exist, the recollection and arrangement of them require that the subject should be made an individual inquiry: on these accounts I leave them as alternatives or views, which, as originally proposed, are designed to serve at best but as indications for the use of those who are inclined to think more minutely and methodically upon the subject.

CHAP. VI.—*The Absorbents.*

§ 1. THE office of these vessels has been before discussed under the title of Growth. From what is there said, as well as from the preceding views, it will be perceived that the prevailing doctrines with respect to the share assigned this system in the organic processes is very questionable.

§ 2. It appears probable, perhaps it may be said indisputable, that the absorbents remove the particles of the structures, when, from other causes, their cohesion has ceased. But if the vital properties belonging to them have any operation upon the fixed particles of the structures, this operation must be preceded by a change in the relation subsisting between the material particles and the spiritual properties by which they were first aggregated.

§ 3. If any such vital relation should be discovered, it will then remain to be decided concerning the life of the absorbents, as whether of the assimilating only, the regular dependent, or of the occasional kind. But until a vital function is ascertainable, it is superfluous to inquire into its possible laws.

§ 4. The strict mode of philosophizing, which has before been sketched, the analytical research, the investigation conformable with doctrines of causation, would proceed upon these objects and these difficulties something in the following way:

§ 5. Each single effect has a history of causation; each effect may be taken separately and this history traced. Suppose then the question to be by what agents, or by what process, do the particles composing a portion of muscle, a muscular fibre, assume their place? We have already answered this question, by imitating, theoretically, the sensible analytical process; but the strict account would require,

1st, That we specify the state of the particles previously to that act, that effect in which it is concerned; which gives rise to our question.

2nd, To explain the change which it suffers, we must specify whether properties are added to it, or whether its condition is changed by a relation with other properties with which it was before in combination, or from which it before received influence.

3rd, Having settled whether the change in the condition of the particle is produced by properties directly conferred on the particle itself, or by abstracting other properties (or separating their alliance)

with which it was before connected; having decided upon this matter, we are next to specify the precise properties which produce the change. Thus a fluid medium contains solid particles, which help to compose its fluid bulk: some of these particles of the fluid leave their fluid state and become solid; why do they leave their fluid state? something produces this change in them: what is it? here we ask for the cause. If the instance of causation were of the sensible kind, we should proceed as above. We should first define the identity of the particle in its original state. We should then examine those substances which were foreign or additional to its original identity; or we should ascertain that it possessed no additional properties, but, on the contrary, that some of its original ones were deficient, which, leaving the particle to be identified by its remaining causes, would explain the history of the change, which we should endeavour still further to confirm by the synthetical process, viz. by that of adding to the changed substance the properties in which it differed from the original ones, with a view to restore its identity.

§ 6. To take another example, supposing it to have been ascertained that the particles composing the textures retain their place but for a time; are particles unsettled from their cohesion, and removed by the influence of vital properties, constituting a function of the absorbents? How we are enabled to reason upon this matter has been partly shewn in the article on Growth; but a perfect analysis would require, 1st, that the constitution of the particles in their fixed state should be ascertained; thus we should come at the knowledge of the precise properties which held them in cohesion. 2nd, The properties by which the particles are identified in their decomposed state must be ascertained; thus, we should understand the precise properties which determined, or were the causes of the change: unless, as is sometimes the case, the properties vanished in the act, or assumed another form, or another combination, having only a transitory relation with the properties belonging to the organic patricles; in which case, the acting properties, or the cause of the separation of particles from others with which they cohered, would not be discoverable in the particles which would remain identified by their own causes, the subjects of a causation which had passed away, and with which they are no longer related. 3rd, Supposing the precise properties concerned in the aggregation to be ascertained, an investigation conducted upon the same principle would then be required to decide whether these were properties which belonged to absorbent vessels, or whether they were obtained from any other source? If an affirmative of the former were upon just grounds to be pronounced, some ingenuity may afterwards be expended in settling the laws by which the interchanges of processes are regulated, between the constitution of the organic particles, the assimilating life with which they are in alliance, the functional properties of the absorbents, their assimilating life, and their structure.

§ 7. As we have no senses for this work, we must be content with the suggestions offered with a view to the attainment, at some

future time, of a theory which shall not be altogether unsatisfactory.

§ 8. Among the many real difficulties which impede our understanding of the relations of the absorbent system, physiologists have perplexed themselves chiefly about one, and that one of no great importance. How, it is asked, do these vessels propel their contents? It may be said, briefly, either by capillary attraction or by an operation dependent upon properties of life. With respect to the first, it cannot be asserted that it obtains in *no instance*, though it appears probable that the laws of matter are in this case, as in most other animal processes, superseded by the laws of life. There are no proofs of absorption by absorbent vessels after death: cysts, before turgid, may collapse; swellings containing fluids may appear to subside; but these changes may be attributed in part to the difference of position in which such swellings are examined before and after death, and in part to that general flaccidity which ensues from the want of distention by the circulation of the blood. Without entering into a full discussion of lesser circumstances, it is sufficient to remark the most important fact which has relation to this subject, viz. that lacteal absorption has never been observed to proceed after death, although the lacteal system of animals have been examined at times when the intestines have abounded with chyle. If absorption were capillary or mechanical, as fluids exist in the intestines after death up to the period of their decomposition, so an unremitting absorption up to this period should take place; and lacteal fluid should invariably be found mixed with the blood of the right side of the heart and its contiguous veins. As such is not the fact, we are compelled to acknowledge the dependence also of this process of absorption, upon the agency of properties of life.

§ 9. With respect to the *manner* in which an absorbent propels its contents, other theories have been proposed; they are none of them worth consideration: and, to add to their number another of about the same value, it may be suggested that the contents of an absorbent are propelled by a vis a tergo, and that the origin of this force is not in the heart, as in the case of the circulation of the blood, but in the absorbent orifices; that is, fluids, &c. are incessantly drawn into the mouths of the absorbent vessels by the affinity which the life of these spheres has with certain particles: that the vital properties perform this function in connection with their assimilation, and hence these properties have relation with *successive quantities* of the fluids they affect; which process at the absorbent orifices being unremitting, gives rise to a circulation in the tubes by a vis a tergo.

§ 10. A process which has been mentioned in the article on Growth may be here again adverted to. If a portion of nerve is removed, the intervening substance by which the interspace is filled up gives place to the progressive growth of the nerve. It may here be said merely, that absorption is subservient, under certain circumstances, to the laws of growth.

CHAP. VII.—*Secretion.*

§ 1. THE secreted fluids are generally produced from arterial blood: there is one, the biliary, which is said to be formed from venous blood. Again, secretions are the products of glands and of secerning extremities, and of surfaces; and they are natural, or the result of disease.

§ 2. It seems proper first to decide from *what blood* the secretions are produced? If it is settled that secerning extremities of arteries are in general given off, before those tubuli communicating with the veins; it may be inferred, on grounds of analogy, that secretions in general (being formed by secerning extremities) are obtained from arterial blood, because they are produced from vessels, the fluid of which has not yet acquired the character of venous blood. Thus far we are furnished with an argument of analogy, if the grounds of the analogy have been sufficiently ascertained. I am, however, acquainted with no certain proof that the secerning system of a gland is given off before the terminations of the arteries in veins.

§ 3. It seems probable (and yet the foundation for the inference is in some respects questionable) that secretion in general takes place from arterial blood. The results of injections, which are known to favour the conclusion to some extent, alone can prove it; but of these I am not satisfactorily informed. All the other processes of the living state appear to require the presence of oxygenated blood; and upon this general fact we may, nothing appearing to the contrary, infer that the relations engaged in secretion, which is an animal process, acknowledge the same law.

§ 4. It cannot be determined whether the secretion of a gland is produced from arterial or venous blood, by a ligature upon the communicating trunks. If, for example, the renal artery were tied, the secretion of urine might be suspended merely because the part is no longer supplied with blood of any kind; and if the vein were tied, the ligature would be upon the trunk, while, if there were any venous branches which gave off secerning extremities, less than themselves, they must, as may be witnessed by observation, be those which are contiguous to the venous origins.

§ 5. That, however the secretions take place from tubes which are given off previous to the terminations in veins, it seems war-

rantable to conclude from this fact, in addition to the general analogy before spoken of, viz. that the circulation in all the perceptible ramifications of veins tends towards their trunks, while the reverse happens with the arteries.

§ 6. One exception to this remark occurs in the instance of the vena portæ: and here, agreeably with the exception, an office of secretion has been inferred, though how justly is indeed, without the aid of a strong case in point, merely from *a priori* reasoning, extremely dubious. The branches of the vena portæ, instead of collecting towards a trunk from minute beginnings, as is usual, are distributed from a trunk, and are minutely divided in the structure of a glandular viscus. Unless this exception to the ordinary arrangement be admitted as a testimony, I am acquainted with no other proof that bile is secreted from venous blood.

§ 7. Moral reasoning on physical subjects is sometimes absurdly proposed, where there is a deficiency of other proofs. In this way we might be asked, why should so unusual a distribution of a vein occur in the liver, unless it is subservient to the peculiar function of the organ, to the secretion of bile? Why, in the way of parallel it may be asked, did God make men with any livers at all, seeing that as he is omnipotent he might have made them equally well without them? In the latter case, it will be replied, it was God's will that men should have livers; and in the former it must be answered, nature has determined that the distribution of the ven. port. should be different from that of the other veins: if we would know *what end* is answered by this peculiarity, it is not the mere confession of a *peculiarity* that will inform us, but we must trace it by an appropriate inquiry.

§ 8. If mercury would pass from the trunk of the ven. port. into the secerning structure of the liver, and finally make its escape through the gall-ducts, the evidence of such a continuity of tube would indeed be tolerably conclusive on the question; and, for further satisfaction, the experiment might be repeated on the hepatic artery: but as such a proof, although perfectly practicable, has not to my knowledge been attained, I shall allow the matter to rest with these suggestions, stating the argument upon these points thus: there is reason to believe on certain grounds, partly of perceptible phenomena and partly of analogy, that the secretions in general are formed from arterial blood; there is however one instance conjectured, on weak or questionable grounds, of a secretion produced from venous blood; thus indicating that secretion might be produced from either, by a corresponding modification of the powers engaged in the process.

§ 9. In agreement with the agencies concerned in the phenomena of animal bodies, three modes of the process of secretion might be suggested: 1st, that it is a mechanical operation; 2nd, that it is a chymical one; 3rd, that it is one governed or performed by the properties of life. These modes respectively (each having had its advocates) may be briefly considered.

§ 10. 1. That secretion is not a mechanical process is proved by these facts: 1st, that the structure of the secreting organs remains after death; and if a part of the blood were separable by this structure in the way of filtration, the injection of blood into the supplying arteries of the organ should be followed by the separation of that peculiar fluid, which is precisely fitted to transude through such a peculiar structure. Against the force of this argument it might be objected, filtration, or mechanical secretion, supposes a precise adaptation of certain particles to tubes of a certain area or figure, and these being left after death with no other power to regulate their area except that of elasticity, a force correctly imitating the natural one of the circulation may impel into these tubuli particles of a different order, thus substituting another for the secretion of the living state. According to this objection, a dependence of secretion upon properties of life is acknowledged; but the dependence is thus supposed to be upon a vital contractility, which has no other effect than to regulate the capacity of tubuli. But the objection itself (founded indeed only upon a possible fact) assumes that the component particles of different fluids are of different shapes and sizes; some fluids no doubt are capable of a more minute divisibility by the operation of the same agents than others. We find that clear thin fluids will transude readily through substances into which the thick or viscid ones will not pass. Hence the variety of the divisibility of fluids seems to be that more numerous particles of some cohere and make up larger molecules, while fewer particles of others cohere and make up lesser molecules; hence the separable masses of some are large, and those of others small; the former fitted to permeate only large interstices or tubuli of large area, and the latter capable of permeating those of a smaller size. It is hence obvious that the tubes which are large enough to admit (or secrete) fluids composed of the largest molecules, must at least admit at the same time, those composed of the smallest ones, both existing in one common source. Hence urine or sweat should run abundantly through the tubuli testis, which admit the most viscid secretion; and all the mucous and synovial membranes should pour out milk, bile, urine, lymph, water, or blood itself, rather than, or at least mixed with, those thick, infiltrable juices which they are found to produce. Such, however, is not the fact; and secretion in this view, as it does also in many others, appears to be governed by laws very different from those of the mechanical process just considered.

§ 11. That secretions are not produced, or elected, or separated from the blood by chymical affinity appears satisfactorily proved by the facts before insisted upon, viz. that these secretions do not continue after death, &c. If it should be urged, in objection to this proof, that we do not know but the chymical properties may undergo a change at the time of death, I ask what are those properties? The chymical properties of substances remain as long as the substances to which they belong, and which they

help to form, suffer no decomposition. If it be urged further, although the materials (blood and the structures, or rather the latter, as the former may be supplied, recent, by art) suffer no immediate or sensible decomposition, their latent chymical properties may nevertheless suffer a change, to which the suppression of the processes of secretion might be imputed. But this evasion will scarcely be admitted unless it be affirmed that all properties which are not mechanical are chymical; which would leave us still to inquire into the laws of life, only under another title, as, "of the chymical properties which are different from all other chymical properties, and never met with in the laboratory," &c. For the present, however, it is convenient and methodical to designate these unknown properties by a term expressive of the limitation with which they exist, and we have chosen to consider them,

§ 12. 3. As *animal properties*, or properties of life, which suffer the conversion from the living to the dead state; in which latter they are no longer capable of producing the secretions, which are to be reckoned only among the phenomena of the former.

§ 13. If then secretion in general is found to depend upon an assemblage of properties peculiar to the living state, the first question on which we are desirous to be informed is, what are those properties? The answer is, they are not objects of the senses, nor can we even witness their operations; we can infer their existence from results, and we may trace some of their laws by analogy; but we cannot designate them respectively by appellations: or if in some instances, as in those of the powers of contraction, we do this, our appellations are founded only upon some point of analogy with other more familiar agents; while their real nature, their constitution, their alliances, their relations, are scarcely in the slightest degree indicated by such terms. We will not then pretend to give names to the properties of life engaged in the process of secretion; but the properties, as a commencement of their investigation, might be inquired into according to those classes of animal properties before suggested, as whether they are of the assimilating, of the regular dependent, or of the occasional kind?

§ 14. In deciding upon these alternatives, the choice appears to lie between the two former; natural secretion being, as we have reason to suppose, unremitting, we cannot attribute the function to properties obtained from another sphere, by the operation of an occasional cause.

§ 15. But although the natural, unremitting secretions cannot be attributed to those vital properties which we have considered as occasional, yet even these are liable to be modified by communication of properties from a distant seat which is primarily affected. Thus, the passions influence in well known instances the functions of the organs of secretion: the first impression is upon the senses, the next upon the brain, and thence the effect may be propagated

to the kidneys, testes, prostate, &c. The natural secretions may be thus affected by properties of the occasional kind; and by similar occasional causes secretions might be produced, *de novo,* as exemplified in some forms of disease, as when the fore arm suppurates from an injury of a finger, &c.

§ 16. There is no other mode of distinguishing whether functional properties, regularly operating, inhere altogether with the organs, or are habitually derived from another seat, than that division before proposed as a test. We commonly regard the nerves as constituting the medium of intercourse of the vital properties of different seats. We possess a few facts which indicate in the organic system that the nerves are the medium of this intercourse: in the animal system these facts are more numerous and less equivocal. Accordingly, an examination instituted to discriminate between the assimilating and the regular dependent forms of life would be directed according to the analogy furnished by these facts.

§ 17. If then the inquiry was concerning the function of the kidneys, we should thus be led to make a division of the renal plexus, or of the contiguous trunks, from which this plexus is formed. Supposing it possible to complete this object in a satisfactory manner; either, 1st, the secretion of urine would proceed; or, 2nd, it would cease. The unconnected inference from the first would be, that the functional properties of the kidneys are independent on another source; from the second result, the inference would be that these properties are communicated from a nervous centre. The first inference would be liable to this doubt, viz. that although the organ is independent of any properties communicated through the nervous trunks, yet does it not follow but that properties might be derived from another sphere, by relations with the spirit residing in other, as the mixed, structures, which are also continuous. Thus we find in our experiments upon nerves, that the division of the brachial plexus may produce a sloughing, perhaps followed by suppuration of the extremities; in which case a dependence is exhibited upon related properties, which are not furnished by a centre of nerves. This objection, though proper to qualify the inference, is perhaps not entitled to any great weight, any further than that it indicates the design of additional inquiry. The inference from the second result, viz. that the secretion ceased upon the division of the nerves, is liable only to this objection, viz. that, from injury of parts, the function might be destroyed by modified communicated properties, and not by an impeded communication of habitual ones, necessary to produce it. How far this latter doubt is entitled to consideration it has before been attempted to decide. In a general way the cessation of an office in the seat of the inferior distribution of a nerve in consequence of a division of its trunk, has been admitted to prove a dependence, as on properties derived from a source; but if the nerve is deeply

seated, and its division not to be accomplished without much extraneous injury, some suspicions may arise on the truth of the analogy upon which the inference is founded.

§ 18. We profess not to decide on matters which are necessarily doubtful; on such we state alternatives, which in the present case are, 1st, that secretions in general are produced by spiritual properties which live by assimilation in the organs of secretion; or, 2nd, that the secreting function of organs is aided by properties derived from another seat; or, 3rd, that particular examples of both these modes occur among these structures which perform offices of secretion.

§ 19. Notwithstanding a mechanical secretion or filtration of fluids through tubuli or pores has been rejected, it is necessary that an adaptation should subsist in this respect. There are also instances in which secretion appears to be superseded by a mere hydraulic process, as when blood itself is forced through exhalents, as in the serous membranes, &c. which effect results from, or at least succeeds an increased impetus of the circulation. We find this effect to take place in pneumonia, in nephritis, &c. and effusion of blood by transudation is an occurrence which is said to take place not unfrequently in the brain.

§ 20. Seeing then that this hydraulic process occurs sometimes, we are led to a wider consideration of the laws by which in general specific secretions are formed and filtrations prevented. Here we must recur in part to a statement of circumstances already alleged.

§ 21. The tubuli of secerning structures, which admit without impediment the most viscid fluids, should, according to their mechanical construction, admit still more readily the most subtile. Yet we find that these viscid secretions are even unmixed with the thinner ones. Hence it is necessary to infer that the hydraulic laws are superseded.

§ 22. If a fluid which is capable of passing freely through tubuli is forcibly impelled against them (as with the impetus of the circulation) and does not enter them, and if at the same time these tubuli admit a grosser fluid, it is necessary to infer that they admit the grosser fluid, by some agency of attraction, or affinity which is *more efficient* than the force with which the thinner fluids are impelled against their orifices. *In this way*, becoming filled with the viscid, the more subtile fluids are excluded.

§ 23. This power of affinity or attraction we need scarcely inquire after. It is not exerted after death: it is peculiar to, we may say without assuming too much, it is dependent upon, that which distinguishes the living from the dead structure; it is dependent upon the living spirit. With what properties or substances, or with what class of properties or substances, then existing in the blood, is this living spirit related?

§ 24. In answer to this question, it must be remarked, the products of the secreting function are found to consist of chymical

substances. It is hence to be inferred that the vital properties, governing the processes of secretion, are related with chymical ones existing in the blood. On this relation it is only further to be observed, that we know not whether vital properties are directly related with such chymical substances constituting the secretions as are displayed in our analysis, or whether others, not known as chymical properties, but in alliance with the materials of the secretions, furnish the medium of a relation between the latter and the functional properties of the structure.

§ 25. But that properties, not known as chymical, are in alliance with those chymical substances exhibited by analysis in the secretions, appears to be propable of them in general, from this fact, that the products of secretion cannot be imitated synthetically; or the result of a synthetical process, or putting together of such constituents as are decomposed chymically, will not agree with the natural secretions in their character and relations. This is true generally; and in some particular examples the latent, or those properties not known to be chymical, are the most essential, as in the bilious, and more especially the seminal secretions.

§ 26. Hence then, of secretion in general it may be said, 1. the materials of the secretions are combined in arterial blood, so as to be neither distinguished by the senses in this fluid, nor in general to be separated from it by any known means of art; 2. the secretions are separable from the blood by the agency of vital properties; 3. vital properties withdraw the chymical constituents of the secretions from their state of combination in blood by a relation of affinity or of attraction, subsisting either directly between the vital properties of the secretory organ and the chymical constituents, or by a relation of affinity between the former and latent properties, perhaps vital ones, in alliance with the chymical. In the former case, the chymical constituents of the secretions are separated by a direct relation with the functional properties; in the latter case, the relation between these is mediate. A more complex mode (which is also a possible one) of the separation of the secretions from the blood is, that vital properties of the secerning organ pass into the blood and decompose (by relations with its constituents, latent or sensible) the fluids which are secreted. This mode supposes two acts of causation, which, without additional evidence, it is unphilosophical to assume, when the end might be accomplished by one. It supposes that one set of properties pass into the blood for the purpose of decomposing the secretion, and that the affinity before mentioned then operates to determine the course of the separated fluid through the secreting tubuli. As, however, positive evidence has been cited of the relation of affinity, it may be perhaps best to adopt this, without supposing additional possible modes, concerning which, if they are admitted, many alternatives might be proposed. 4. The vital properties producing the secretions combine with the secretions, and exist in these fluids in the condition of *informal life.*

5. The secretions are identified by the properties derived or separated from blood, and by those of secreting organs, which combine with, in order to act upon, to separate, to modify them, and finally to extend their relations. The vital properties themselves of the secreting organs have also a history: we have been content to state that the efficient ones belong either to the assimilating or the regular dependent life. Such is the history of secretion furnished by close analogies with our experience.

§ 27. The minuter mode of inquiry into these processes would require that, being informed of the general laws of the properties which yet remain to be decided upon, we should then specify the properties themselves; as, *What* are the properties which hold the affinity with secretions contained in the blood? or, *what properties* combine with these materials in blood? what properties are so related with, as to separate the secretions from their alliances? what properties combine with the secretions and *help to constitute* them, and remaining perhaps latent, multiply their relations? what properties are furnished by the organ, and what from a distant sphere? with many other questions which it will be time enough to propose when our chances of settling them are improved; at present I fear we require additional senses for this work.

§ 28. The objects to which inquiry might be applied with this view are, secreting surfaces, and glands. The first comprehend the mucous, the serous, and the synovial, membranes, and the surfaces produced by wounds or ulceration; the second, the cutaneous, the salivary, the mucous, the biliary, the pancreatic, the uriniferous, and the seminal glands. Some of these glands concur with the membranes, as the mucous ones of the intestines, and the salivary of the mouth and fauces: perhaps the instances of glandular structure are not to be accurately enumerated or distinguished. The last-mentioned or seminal glands may be taken as an example, and the processes, in agreement with the general view, described thus, or in the following order:

1. Secreting tubuli, communicating with arterial blood.
2. Properties of life, belonging to, or conjoined with, the structure of these tubuli, related with a part of the constituents of arterial blood.
3. History of these properties: they live by assimilation in the glands where their action is exerted; or they are communicated from other seats.
4. Effect of these properties, related with a part of the constituents of blood, to produce the seminal secretion.
5. The seminal secretion consists either wholly of the substances and properties which before existed in other combination in the blood; or, 2nd, it is made by the combination of the properties of the glandular structure with blood, or with a portion of its constituents. The alternatives differently stated are, Is the secretion withdrawn by an agent which does not combine with it; or, changing its form, only adds to its properties, which are not exhibited in any

future relation? or, is the secretion identified, and the peculiar properties which distinguish it conferred, by the union of those vital ones belonging to the structure, with the fluid obtained from blood? The latter appears probable on the following grounds:

1st, If the secretion is separated by affinity, by the vital properties of the structure, it is consonant with the known laws of affinity, that these properties should combine with the substance which they so far affect as to be capable of detaching it from another state of combiuation. Thus far that the secretion is formed by a constitution to which the vital properties of the structure contribute, is strongly indicated, if not proved.

2nd, The secretion is found to possess properties, which may be developed into a similitude of those of the animal in which it is produced. Hence, if those precise vital properties which are afterwards exhibited by the secretion, are not those which before existed in the structures, and are conferred on the secretion; at least, properties agreeiug with those diffused ones of the animal in which the secretion takes place, must belong to the glandular structure, and must then operate by a causation more complex than we have hitherto supposed; this, at least, is to be inferred from the fact that the constitutional peculiarities of various seats are transmitted to the offspring, &c. Upon the ground then of these considerations, which are indeed deserving of some reliance, and to avoid the confusion of still greater subtilties, we may thus continue the enumeration of processes.

6. Vital properties of the glandular structure combine with the gross fluid secretion produced from blood, and constitute its latent vital properties, the history of which has been sufficiently discussed in our first chapters.

7. As in the other instances of secretion there is reason to believe the governing properties are in part obtained from some other seat, so in this it has been inferred in the chapters alluded to, and rested priucipally on the fact that this secretion contains all the properties of the animal, or those combinations capable of producing all the textures, and of displaying all the phenomena of life: so, in agreement with preceding views, and principally on the strength of this fact it is concluded, that the functional spirit of the testes is formed by a participation of that existing in every sphere. Whether the nerves are the medium of this communication, I neither know nor care. Some may in this case use the word sympathy; be it so, sympathy is a causation among these properties which I have been taking some pains to trace.

8. The secretion contains the properties conferred by the structure, and those withdrawn from blood; it is that which it is made by these two; they are related, they modify each other, and final purposes are accomplished by them in additional stages of causation.

CHAP. VIII.

Relations of the Organic Life in the Nervous System.

§ 1. LIFE, or the organic spirit in the nervous system, maintains its own identity, or assimilates itself from blood, in the same manner as in the other structures. But the properties of life in this system appear to have an intercourse so rapid, so frequent, so important in its results, so subtile, so mysterious, so difficult of investigation, that this system on these accounts deserves rather to be particularized than some others.

§ 2. The assimilating life in the nervous system is that which belongs to the seat, to every seat in which life is maintained. This is to be inferred on the ground before stated, that properties which maintain themselves by assimilation depend only, 1st, on their own existence, and, 2nd, upon a supply of that material from which their existence is renewed. Hence the assimilating life of the nerves is every where independent of the other parts of the system, at least it has no *direct* dependence; the indirect will be hereafter spoken of.

§ 3. Such a conclusion is furnished *a priori*, and we find it to agree with facts to a considerable extent. The nerves are the organs of the animal functions, or those of sense and motion: a dependence is obvious, in the exercise of these functions, upon their centres, as the brain, spinal marrow, &c.; accordingly, we find that if the nerves of a voluntary muscle are divided, that muscle no longer obtains those properties which are derived from the centre of its nerves, and which enable it to perform voluntary motion; the faculty of sensation is also suspended or destroyed in the inferior distribution of the divided nerves. Not so with the *organic assimilating life:* the terms of the maintenance of this are not violated, its organic spirit survives the division of the nerves distributed in its seat, it is supplied with blood, and it preserves its identity, maintaining the cohesion of the structure, and exhibiting its usual characteristics.

§ 4. Thus far the distinction and the independence of the assimilating life of nerves is plain to our experience. But we are called upon, in order to extend or correct our view of this same independence, to consider facts of the following kind. If a sciatic nerve

close to the spine sustain a certain injury, the organic life will cease in the spinal marrow and in the brain, and consequently elsewhere: if the spinal marrow be divided in the middle, the parts below will be paralyzed; they will for a time maintain their organic life, but finally this will cease, as well as the organic life in seats more immediately connected with the superior half of the spinal marrow, and with the brain: if the brain be injured in its basis, the life of the spinal marrow will cease, and that of the other parts will die; if the brain be injured in its superior parts, its entire functions will be impaired, and finally its life, as well as that of the spinal marrow, will probably cease from the same cause. These are the descriptions of facts, which require to be a little further analyzed.

§ 5. If the medulla spinalis be divided about the middle of the dorsal vertebræ, death is not the immediate consequence; the organic assimilating life is preserved for a time in the nervous structure both above and below, but the general extinction of this principle at no great distance of time will succeed this injury. From the fact that the assimilating life is maintained for a time in this system both above and below the place of division, we are disposed to infer the independence of the inferior on the superior parts, and *vice versa.* From the fact that death does succeed to such a division of the spinal marrow, though an interval as we have reason to think in some animals of several hours might elapse before this event takes place; from this latter fact two inferences are suggested, between which it remains for us to choose, 1st, that the assimilating life ceases from privation of properties which are necessary to constitute its identity; or, 2nd, that it ceases in consequence of *disturbed* relations, as by foreign properties, or a preternatural condition of local properties, which have a preternatural relation with those in another sphere; the result of the communication of such properties is the extinction of the assimilating life in the sphere to which they are imparted. To decide upon these inferences, will require but a short discussion.

§ 6. 1. That the assimilating life does not cease either in the superior or inferior parts of this system by *privation* of properties, or by interruption of those which we have called the regular dependent, is indicated forcibly by the fact, that the life of the parts in question is maintained for many hours after their communication is intercepted; and the same conclusion is still more satisfactorily proved by the general fact before cited, that assimilating properties must be independent of every distant sphere. Hence the rejection of this alternative gives room to admit the other, viz.

§ 7. 2. That if the assimilating life ceases in any part above the place of division of the spinal marrow, the properties directly concerned in its extinction can be those only which are foreign; or, to describe the change more particularly, the vital properties interested in the injury assume in consequence (as does the vascularity of the structure also) a preternatural state, and the properties composing this preternatural state have a relation with distant ones which does not belong to the condition of health; the result of this relation is

the extinction of the assimilating life in a distant seat by properties communicated.* This inference granted, we have to trace still further the process by which according to this method universal death eventually supervenes.

§ 8. It has been insisted upon that the only conditions of the continuance of life in every seat are the existence of life, fitted for assimilation, and an adequate supply of perfectly formed blood. Hence, according to this view, we are again furnished with two alternatives of the mode in these instances of universal death: 1st, the direct one, implying that foreign properties (or the preternatural state above spoken of) are related, not merely with superior or inferior parts of the nervous system to a trifling extent, but with the whole body, producing through the medium of the nervous continuities an unassimilating state of the diffused principle, according to the process just described, as belonging to the parts above or below the place of the division of the spinal marrow: this is our first alternative; the 2nd is the indirect mode, as when, in consequence of the cessation of the assimilating life in one sphere, a functional one which depends upon it ceases; which functional life is related with the diffused spirit by its offices, in respect to the formation or the circulation of the blood.

§ 9. 1. That the injury of the spinal marrow produces universal death by properties communicated every where to the diffused spirit, or that death is produced in the direct way, is an alternative on which we can cite no proofs. At the same time that this mode of death is an improbable one appears from the following considerations: 1st, life ceases to assimilate in all the structures, with but few exceptions, and those rather equivocal at the same time; 2nd, If properties originating at the place of the injury should be allowed to possess a relation by which the life of all the structures might in the direct way be rendered extinct, the course of the propagation of these properties (which, as is proved by the succession, is not sudden) must be through the nervous organs, and the contiguous assimilating life must suffer before that which is remote. Hence, although the relation of the properties engaged in the injury should be directly with the spirit in distant seats, life in such seats must otherwise cease, as if no such relation were possible, by the destruction of that existing in the spheres of the nervous organs, upon which functions depend which are necessary to the formation or the circulation of the blood.

§ 10. 2. On our 2nd alternative, viz. that the diffused life is made by the injury we are considering to cease *indirectly* or through the medium of the blood; on this alternative it is proper only to remark, that this mode of death must happen from the extension of

* It is possible, agreeably with the modes of causation, that the new relation may be such as to destroy the assimilating life of another seat, by withdrawing properties necessary to its identity. This, however, cannot be ascertained, and if admitted, does not prove the dependence of the assimilating life of one seat upon that of another.

the effects of the injury to contiguous parts of the nervous system, upon which the formation of the blood depends, as to those parts at least which are necessary to mechanical respiration.

§ 11. To define then with greater precision our conclusions upon this subject,

1. The life which assimilates in the nervous system, as in the mixed structures, is every where independent of spiritual properties which live in distant spheres.

2. If the assimilating life of one sphere is affected or destroyed by an injury or a cause which operates primarily upon the life of another seat, this happens by a new relation, conformably with a new or foreign state, which has been produced on the spirit by the operation of such cause or injury.

3. There are two ways in which the preternatural condition of a primary, may influence the secondary seat of change: one is direct, as by communication of foreign spiritual properties; the other is indirect, as by an influence on the formation or circulation of the blood, with which the spirit in every sphere holds a common relation of dependence.

4. The assimilating life is always affected in the direct mode by additional or preternatural properties: the functional life may be affected or destroyed by foreign properties conferred, or by privation of natural communicated ones; in either of the latter cases the essential change is of the assimilating life, upon it all phenomena ultimately depend. To extend a little our illustration.

§ 12. An injury of one part of the spinal marrow, or an injury of one part of the brain, may be directly extended to that cerebral portion, the assimilating life of which furnishes the functional properties of the diaphragm, and are necessary to respiration; the life of this portion being thus modified, respiration ceases, and death is then extended, in the mediate way, to parts which have no relation with the primary seat of the injury. Thus also in an injury of an extremity, as a fracture of the leg, the local state of vital properties is extended to those which govern the movements of the heart, the pulsations of which in the course of a few hours are increased, perhaps from 70 to 130 in a minute: properties which govern the caliber and phenomena of the vessels of the brain, might from the same extension of preternatural influence assume that state which constitutes phrenitis. In short, from the interchange of these two modes of affection, the direct and the mediate, complex changes and relations may be variously exhibited, and they furnish a history in almost every seat, which is to be traced only by a specific investigation. This matter might be pursued more minutely: the *time* which elapses in the succession of these phenomena is a point of important but of difficult explanation, it belongs however more properly to the subject of disease.

§ 13. It would appear that an inquiry into the physiology of any given portion of the nervous system can scarcely be separately pursued. The complexity here hinted at must occur in the investiga-

tion of functions. It remains that the seats of functions should be discriminated: the relations of the properties of different seats with each other will principally comprehend their physiology. I shall take only one or two examples with a view to indicate the objects of inquiry.

§ 14. The method by which we come at the knowledge of the seats of functions of nerves is of the analytical kind. We take an effect, in which we suspect from analogy the offices of nerves to be engaged, and we trace in this system the laws and processes which are exhibited in the instance under consideration. Thus, for example, let the effect be the movement of the muscles of respiration: does the power which animates the muscles of respiration belong to their structure? is it a property of their assimilating life, or is it dependent upon another seat? We find that it ceases upon the division of the phrenic nerves; and as it is assumed, on grounds before exposed, that division of a structure is a test of the dependence, or the contrary, on properties which are propagated only by its continuity, so in this case we infer that the action of the muscles of respiration is a function dependent upon the centre of the phrenic nerves.

§ 15. The inference thus attained is that some properties, necessary to the action of the diaphragm, are derived from the spinal marrow; the next step in our analysis requires that we should specify what these properties are. Before this question can be answered we must have reduced the whole of the properties concerned in the effect to certain classes, that we might say, these are the properties inherent in the structure; these are the properties related with them, which, when united, identify the power of respiration; this is a stimulus merely, or a property which is also common to externals, or to many substances; this property is given off from the assimilating life of such a seat; this is formed by relation of the assimilating life of such a seat with that of a secondary source; the relation of these properties is direct; of those, mediate; these act by affecting the caliber of vessels, or by an operation upon the blood; those, by modifying its formation. Such definitions as these we must hope to find accurately applied to their examples in the progress of research: the time however, if ever, is distant. We cannot here pursue to any extent the true analytical method, according to principles of causation, so as to specify of the properties identifying an effect; this change takes place by the addition, this by the abstraction of such properties, leaving the effect to be identified by remaining causes.

§ 16. There appears, it might be said, to be an inconsistency, or at least some confusion, in the evidence which has in these views been assigned to the experiments of dividing the nervous structures. The inconsistency alluded to is this, if a function in the seat of the inferior distribution of a nerve ceases upon a division of the trunk, we infer the dependence of the function upon the centre of the nerve which supplies its seat. If the functions and life of the superior parts of the medulla spinalis cease, after a division of the spinal

marrow at the lumbar vertebræ, we do not from this instance of division, although followed, as in the former case, by a suspension or cessation of certain phenomena, infer, as in the former case, a relation of dependence. This objection requires a little explanation.

§ 17. If the results of the division of a structure prove dependence in one instance, they must also be allowed to prove it in another, provided the circumstances of the structure furnish no exception, and provided also the results of the division are the same. These then are the points to be ascertained in cases where the above distinction is attempted. The question only respects functions, the independence of the assimilating life being necessary.

§ 18. In these cases, in which dependence is inferred from division of nerves, the function supposed to be dependent ceases *immediately* upon the prevention of intercourse between the seat of the function and the source of its properties. *The function must always cease as soon as the nerve is intercepted, because the properties communicated under a continuity of the nerve cannot assimilate; if they did, there would be an end of the dependence.* Hence, when phenomena *immediately* succeed to division, we must in every case infer the dependence we are considering; but if an interval of time elapses between the prevention of intercourse and the cessation of phenomena, than the analogy in this essential circumstance is destroyed; and, for the reason just stated, dependence cannot be inferred. Thus, for example,

§ 19. If the sciatic nerve of a rabbit be divided close to the spinal marrow, the animal, as I have found in the experiment, might become convulsed and die within 36 hours. We do not in this case infer a dependence of the functions of the superior parts of the spinal marrow on properties obtained from the inferior portions of the sciatic nerve, because these functions continue for a time, whereas in the case of dependence they would *immediately* cease. The functions of the spinal marrow are made to cease by a new relation, which is opened between a disordered condition of the nerve at the place of injury, and the functional properties of the superior parts of the system; just as it is rendered more than probable by the same argument, the *action* of the heart is maintained by its assimilating life, continuing after the division of its nerves, but is destroyed by a new relation which is opened with it by certain injuries of the spinal marrow.

§ 20. When functions are made to cease, or life is destroyed by this disordered or foreign state of the properties engaged, it happens either directly or indirectly: directly, as in the example of the sciatic nerve just mentioned, that is, a new relation is opened between vital properties without being produced by disorder of the circulation; and indirectly, as when the life of that portion of the brain or spinal marrow which furnishes the power of the respiratory muscles dies, from an injury inflicted upon the superior parts of the brain. Thus a wound of the brain may for thirty-six hours appear to produce but little derangement: at this period phrenitis may supervene,

and the death of the independent functions may succeed to this condition of the blood-vessels. Whether life ceases wholly in this instance from disorder of the circulation, or whether a change which is directly propagated from the place of the injury, to parts otherwise not related, can scarcely be decided; at least, the precise share of each of these modes of impairing function or destroying life cannot be defined. By these modes and their complication, functions are modified or destroyed where the relation of regular dependence does not subsist.

§ 21. The ways in which the effects of causes are extended beyond the primary seat of their operation appear simple; they are reduced to two, the *direct* and the *mediate;* but their complexity may be greatly increased. As the direct and the indirect might be mixed, or the direct may have complex relations, as when functions cease in a third, by the relation which a primary, has with a secondary seat; or a complication might grow out of the relations between the direct and the indirect modes of influence in different seats; their connexion may be extensive or partial, common or particular; or obtaining in some seats and not in others: these varieties all tend to modify phenomena. Such a tissue of subordination and re-agency can be unravelled only by specific investigation, which must respect some or other of the numerous examples in which it is displayed.

§ 22. It has been attempted to establish dependence by *injury*: this mode of experimenting has, in some of our former pages, been rejected, and the grounds of the rejection are there stated. I have only further to remark upon this subject, that when muscular motion is for a few minutes exhibited in dependent seats, under the infliction of an injury which destroys the source of their properties, this happens, not by an assimilation of functional properties in the dependent seat, but by a progressive disorder of their source; the injury of which, though speedily, is not immediately fatal. Thus, an animal will use for a time vehemently the voluntary muscles, after his head is cut off: the reason is, that the spinal marrow is capable of supplying properties for muscular motion, until life is destroyed mediately, as in this case, by the prevention of respiration, or an influence connected with the blood. This circumstance indicates that the voluntary powers of the muscles supplied by spinal nerves is not dependent upon the continuity of the spinal marrow with the brain; at the same time it must be remarked, that a different conclusion is indicated by the paralysis of the lower extremities, which is known to succeed certain injuries of the medulla spinalis about the lumbar, or even the dorsal, vertebræ. We find it agreeable with our experience in other respects, that when properties of motion are no longer communicated to the muscles from a true or unequivocal source, the powers of motion cease immediately and entirely in the dependent seat; just as a leg *drops*, and is not *convulsed*, the moment that an axillary plexus is divided with one stroke of the bistoury.

§ 23. The relations of properties of nerves may be inquired into upon grounds of analogy, and by the mode of investigation many times repeated in every case in which a function is displayed.* Thus it may be inquired after in the instances of secretion before enumerated, and in the parts of the nervous system, with relation to each other: this latter examination will refer principally to the brain and spinal marrow; and, with but few exceptions, and those almost equivocal, will respect the animal and intellectual phenomena, rather than those of the organic life, with which we are at present engaged.

§ 24. Can we then, it will be asked, define in abstract no criterion by which the seats of dependent functions might be assigned, and the functional dependent distinguished in every case from the assimilating properties? No such criterion exists: we may say those phenomena depend only upon the properties which assimilate in their seat, which phenomena take place merely as a result of the relation between blood and the living spirit of the seat. Thus much might be set down as an abstract, general criterion; but the investigation we have indicated must be applied in every instance before we can decide the question of dependence, &c. in the examples in which this question might arise. Thus, it cannot be said either that secretion is produced wholly by the assimilating life of its seat, or that secretion is a process dependent upon properties obtained from a distant sphere, because to the former assertion it would be replied, the secretion of gastric fluid ceases upon the division of the eighth pair of nerves; and to the latter it would be objected, that a wound will suppurate below the place of the division of an axillary plexus.

§ 25. After discussing certain relations subsisting between the properties of the nervous system, the more difficult inquiry must be suggested here, as on former occasions, concerning the identical nature of the properties engaged in these relations. Our causation teaches us that for every diversity of effect a different cause is to be assigned: this axiom is incontrovertible, and therefore the different phenomena of the nervous system are to be referred to so many different agencies. It has long been a favourite design with certain physioligists to evince the identity of electricity with the properties of the nerves; but the inferences deduced from the facts prove such physiologists to be but very indifferent reasoners. Electricity will produce muscular contraction, after certain functions, characteristic of the living state, have ceased: so also will irritation of the muscles of an amputated limb with a *scalpel* excite their contraction. From these facts, there is as much reason to pronounce life to be a scalpel, as electricity to be life. Electricity will excite *powerful* actions of the muscles after death; other substances, perhaps mechanical ones, will excite *weaker* contractions; the former is therefore to be con-

* The functional instances have formed the subjects of preceding pages, and need not here to be repeated.

sidered a powerful stimulus, the latter as stimuli of a weaker kind. Certain phenomena of the branches of nerves, dependent upon their connexion with their centres, are said to be producible by electricity, when this connexion is intercepted; as, if a portion of nerve were removed and an electrical conductor substituted, the phenomena which otherwise occur during the integrity of the nerves may be produced by electricity. This experiment is just as conclusive as former ones; for if electricity is communicated to the muscles, or to the branches of nerves, it matters very little in what way it gets there, whether by means of a conductor or by a common electric shock: here, also, is the parallel of the scalpel; for the nerves of an amputated limb is totally separated from their centres, yet irritation with a scalpel will produce the contraction of its muscles, &c. But electricity, it is said, will substitute the influence from a centre of nerves in processes of the organic life, as in digestion. Granting the fact (which is, however, extremely questionable), it proves only, as the other facts respecting the same agent prove, that certain properties derived from a nervous centre may be *substituted,* and consequently that such properties come under the denomination of stimuli. A passion of the mind may produce a temporary diarrhœa; so also may Epsom salts, or rhubarb; yet we should scarcely call rhubarb a human passion. If electricity is life, it should produce the phenomena of life: if it fail of producing one effect of the properties of life, its identity with these properties cannot be admitted, because life in this respect is different from electricity. The most that can be assumed from the facts collected on this subject is, that electricity *holds a relation* with life; that certain of the properties of life may be substituted by electricity, and in a less degree by other agents, in which cases these properties are regarded as stimuli, or as properties which are common to many substances.

§ 26. The influence from a centre of nerves produces the contraction of a muscle; so will electricity: thus far there are properties in common. But the influence from a centre of nerves produces *voluntary contraction* of a muscle, or modifies its contraction, in connexion with the mind, and volition: so does not electricity. Life produces secretion, circulation, &c.; electricity will excite life in connexion with the organs of circulation, secretion, &c. or it may appear to produce these effects after they have ceased by the first changes incident to death; that is, while certain properties of life remain free to hold a relation with such an external, or such a stimulus: but electricity will not produce these effects when life has entirely ceased, or when all the processes of the death of the spirit are accomplished, and when those properties forming irritability, and the last to assume their final change, or alliances, have become extinct. Life forms blood from food: so will not electricity in connexion with the same organs, and in the same temperature; at least this may be presumed. Life maintains itself by assimilation, electricity is produced by different

laws, and in a different manner: life produces the organization of an animal; electricity has never exhibited the faintest approximation to such a power. Not to be tedious in enumerating differences, where, in ten thousand phenomena, there are scarcely half a dozen points of resemblance, and those common in a lesser degree to other substances, it appears that in the intercourse of vital properties these properties in some instances are to be reckoned as mere stimuli, and produce the phenomena of a distant seat in conjunction with the regular properties of such seat: to what extent they are to be considered in this light, in the examples of dependent life whether regular or occasional, is to be determined by the ascertained instances in which these properties may be substituted. That electricity should have an intimate relation with life is not more extraordinary than that grass should furnish the materials of the animal structures; but neither is grass a muscle, nor is electricity life, until by causation they are distinguished from other forms of existence, and *identified* as these creations.

This section concludes our physiological sketch. The design hitherto has been to shew distantly how life is maintained, and to point out those particulars for further inquiry, the possession of which would make us almost perfect in this department of science. Physiology has never been investigated with these views: the pursuit of it has turned principally on mechanical arrangement, which, with respect to function, has no other importance (which indeed is very considerable) than belongs to an instrumental fitness to the powers by which it is actuated. The design has been to incite attention to these powers, to shew that they might be reasoned upon with a probability perhaps equal to that which is boasted in those coarser topics which are commonly received as more level to the faculties with which men are endowed. Many circumstances or particulars here unnoticed concur also with those which have been spoken of in the business of the formation and support of an animal body: these have their respective histories and relations; to particularize which, would be very little more than to swell by repetition the views, the analyses, the indications, concerning which as much has been already said as is conformable with a general design. The condition of life having been thus faintly exhibited, it remains that we trace it in the two further stages of disease and death.

SECTION IV.

GENERAL NATURE OF DISEASE.

CHAP. I.

Origin of Disease according to Doctrines of Causation.

§ 1. THOSE conditions of the body designated by the terms health and disease are fixed by the consent or agreement of mankind; that is, one state of the body is said to be a healthy, and another a diseased state. To settle these definitions, then, we have only to describe the respective conditions which men have agreed to call by these names.

§ 2. By the word health is implied a certain condition of all the organs and functions of the organic, the animal, and perhaps we may include the intellectual, systems: the latter, at least, is at present foreign to our purpose. The *certain condition,* implying that of health, has been said to consist of a natural and easy use of all the functions: this definition, however, is not perfect; for to say that a natural function is a healthy one, is a mere substitution of terms which alike require a definition; and to say that health is an *easy* use of the functions, is to say more than is true, for the kidneys may secrete *easily,* that is, without pain, in diabetes, yet it would be suspected that the state of their function was not a healthy one; or there may be disordered action of the heart without pain, or a furred tongue without an uneasy exercise of its function, or a wen upon the shoulder, or on the head, not uneasy in itself, nor at times productive of uneasiness; yet at these times nevertheless a disease.

§ 3. But although such objections may be raised to the definition of health, which assigns it to consist of an easy use of all the

functions, yet a better definition cannot be given without an elaborate description of that state of all the organs respectively, which may be agreed to constitute a healthy condition. Thus, beginning with the head, it may be said the condition of *health* requires that the head should have no tumours on it, that the skull be covered by the scalp, that the scalp be supplied with blood, that its structure should be of such a kind that its sensibility and its life should be so and so; and then an average thickness proper for the cranium must be defined; and then of the contents of the cranium, &c.; all of them endless themes. Let us therefore be content with a looser, with the loosest, definition, rather than incur so tedious a history. Let us say that health is one condition of the body and disease another; and that men are so well agreed about the use of these terms, that they do not require to be any further explained. But, if it should be resolutely insisted that some standard between health and disease should be established, we shall, in the respective instances, readily discover such a criterion, although an universal one cannot be proposed. It has indeed been said, to this effect, that health is such a condition of an animal as is agreeable with all his purposes. It then comes to be asked what are his purposes, as, for example, those of a man? is the art of flying one of his purposes? no: why? because he is not provided with the organs; in the same manner, walking or running would cease to be among the number of his purposes, if he should happen to have lost his legs.

§ 4. According then to this common understanding or consent, to which we have referred the definition of health and disease, health is a certain state (settled by this common agreement or understanding), and disease is a change or modification of the state of health.

§ 5. Health is the effect of the causes which have to some extent been traced in the preceding sections. These causes concur to identify the condition of health. Disease is a modified or altered state of the causes which produce health.

§ 6. An healthy condition of an animal is the sum of the causes which concur to this end: so, if one only of these causes should be so modified as to impair this concurrence, the animal may then be said to be unhealthy or diseased. Yet, under a modification so trifling as this, many parts, or many, perhaps by far the largest proportion, of the causes of the animal may not participate in this modification, or may be in a state of health. This distinction indicates the first step of analysis. If the healthy identity of an animal is dependent upon all his parts, a deviation from this condition in any will make an unhealthy state of the animal. As then we have analysed his parts, with a view to come at the minuter knowledge of the conditions of health, so we must descend also to the state of constituents, in tracing the history of disease.

§ 7. Disease is primary, secondary, or general, and it is accidental or spontaneous: primary, as when it originates in one seat

by a causation peculiar to the properties of this seat; secondary, as when disease is extended from the original, to a related seat; general, as when, in some form, few parts of the system are exempt from it; accidental or foreign, as when disease is produced by external agents, which are related with properties common to the healthy condition of the species, as in the instances of wounds, poisons, &c.; spontaneous, as when disease happens without any external assignable cause, or as when it is excited by a natural cause, as air, food, &c. operating upon a state of constitution which does not belong to the healthy condition of the species. Of these classes, our principal business at present is with spontaneous disease.

§ 8. Before we enter upon the discussion of the general origin of spontaneous disease it will be proper to give an instance of it, which will serve the purpose of illustrating our reasonings without the necessity of a frequent appeal to examples. A person attains the age of twenty, enjoying generally good health: at this time a slight cough occurs; the action of the heart becomes a little quickened; the temperature of the skin is irregular, sometimes cold with slight rigours; these succeeded by flushes of heat, and the blood forced into the cutaneous vessels of the face (or rather *admitted* by their preternatural dilatation) gives a vermilion tint which is, perhaps, supposed by the ignorant an indication of health; this, which is a feverish state, continues a short time; the cough becomes more troublesome, the voluntary muscles are sooner fatigued than usual; this debility is increased by periodical sweats, which are perhaps the spontaneous relief of the febrile diathesis. The person observes, perhaps in the morning, after a fit of coughing, that the mucus is tinged with blood; or a little blood, which has been gradually forced up from the lungs during the night, is expectorated with the first effort, appearing to have lodged on the top of the glottis; the fever is now continued, with evening exacerbations, which perhaps terminate by an expectoration, in which more blood is perceived; a pain is felt in the side, the bulk of the body is rapidly dimished; this state continues, the lungs cannot be inflated without exciting pain or cough; the expectoration becomes purulent; the feet swell; the powers of locomotion are almost extinct; respiration becomes quick and laborious; the pulse is raised perhaps to 160 in a minute; it may then sink to 70 or 80; the extremities are cold, and the patient dies. This will be recognized as one form of pulmonary consumption; and this is an example among many of spontaneous disease.

§ 9. These which have been enumerated are the *symptoms* of the disease; or they are effects, each of which has an history of its own, which we shall thus trace in our analytical method. We have mentioned the cough as the first symptom: this may not be true; but we must begin at some point. What produces the cough? *irritation*, it will be said, which has its seat in some part of the membrane which lines the trachea, and is continued into

the bronchial ramifications: this irritation, it will be replied, affects the respiratory muscles sympathetically, and thus the coughing is produced.

§ 10. Irritation is said to be the cause of our first symptom; and what produces irritation? it is excited by cold: with what, then, is cold so related as to produce irritation? is it with the organic fibres? no, for cold never makes dead people cough; is the cold *so related* with the *blood* in the vessels of the part? no, for there is always blood in the vessels of the part, and this blood shall many times be surrounded by an atmosphere of the same temperature, &c. yet it will not produce a cough; or if this answer should be excepted against, as it might, we will add, dead vessels may be filled with blood, but we have no experience of cough having been produced by a simple relation between blood and air. This cough then takes place only during the presence of life, and must therefore be considered as one of the phenomena dependent upon life.

§ 11. What then shall we say of the state of irritation? merely that it is a disordered or modified condition of life, which produces those effects, those symptoms, which are just referred to it. There are few terms more common in medical subjects than this word irritation. A modified condition of the spirit is meant by it; it is employed to designate almost any modification, and by no means a particular one: thus we say a part ulcerates because it is *irritated*, as by a foreign body; or a wound is painful and secretes bad matter, because it is in a state of irritation; or sympathetic disorder of a system, as of the nervous, takes place from irritation of one part; or a membrane, which would not otherwise secrete, throws out mucus because it is irritated, &c. These are all instances of irritation, yet the state which is the cause; the agent producing different phenomena, though related alike with the common material, must on this account consist in each of a different combination or assemblage of properties; in other words, the irritation which makes a cancer spread is different from the irritation produced on the schneiderian membrane by a pinch of snuff. If then we retain this word, or in our future use of it, let us understand that it is designed to express a modified condition, liable to much variety, of the spirit, and not one precise identity of it.

§ 12. To return to our symptom. The cough, it is said, is produced by irritation; the state of irritation, by a relation between properties of life, the seat of which is in the membrane lining the trachea, and the properties of the atmosphere. But the same person may, many other times, have been exposed to the same atmosphere, which has not before produced a cough; or many other persons might at the same time have been exposed to the same atmosphere without such exposure being followed by our symptom. If the atmosphere be the same in these instances of different results, where must we look for the cause of the diversity? We have no choice: we must look for the difference where alone

it can exist, viz. in the condition of the part which is the seat of the affection. We have already attempted to settle with what order of the properties of this part the atmosphere in this case holds its relation, and we have found it to be with the properties of life.

§ 13. Thus it appears necessary that the properties of the seat should have undergone a change, preparatory to that of *irritation* by atmospherical influence, to which our symptom has been more immediately attributed. This change implies a different form or combination of the properties making the life of the part; the atmosphere is related with this form (which, as it tends to disease, may be called the disordered condition), so as to produce the symptom in question; while it is not related with the healthy state of these properties, so as to produce such an effect in conjunction with them.

§ 14. This first deviation from a healthy state of the properties, this peculiarity in the constitution of the spirit, this state which precedes the symptoms of disease, by which we judge of its presence, is expressed familiarly by the word *predisposition*. This predisposition we have shewn to consist of a change of the combination, or assemblage of the properties which constitute a healthy state.

§ 15. The state of predisposition must precede every spontaneous disease, at least in its primary seat: this, without recurring to particular examples, is sufficiently obvious from the fact that the same exciting causes, as they are called, do not affect others in the same manner, and perhaps have entered into the habits of the individual who suffers the disease for many years, as in our example, without being attended by preternatural effects. Our next inquiry is into the history of this state of predisposition.

§ 16. Our topic is otherwise thus expressed: Why does that change take place in the properties of a seat, which disposes them for disease? We infer, in agreement with our general principles, that this change, like every other, is accomplished by an act of causation, of which there are two modes, viz. the addition and the abstraction of constituents. We have many times before led up to that point where analysis ends: here again we must recur to it. It requires, in order to specify *what properties* are added to, or *what* taken away from, the healthy, in order to produce the predisposed condition; for this purpose it requires that we should know the properties concerned in either case; but as they are not objects of the senses, we cannot pursue the analysis in this strict way.

§ 17. Our first change of the healthy state in a particular seat is thus easily reduced to a conformity with our general principles. But, in admitting the conformity in this instance, the following difficulty occurs. If the predisponent condition is produced, either by properties added or causes taken away, it would appear that they must, in the former, be communicated from some other

seat; or, in the latter, that some power, as one of affinity, must be exerted by a distant seat, for the purpose of withdrawing properties from that which becomes the seat of disease: in either case, implying a first change to have taken place in a related part, and thus precluding in fact an *origin* of disease in any part; for the same modes of causation must every where obtain. This view suggests another origin of disease, or of the origin of the change from the healthy to the predisponent state, viz. change happening spontaneously in any given seat, and change happening in one seat from a previous change in a related one: our difficulty belongs to the first of these.

§ 18. The spontaneous change originating in a given seat happens from the operation of some cause which did not before prevail. We have assumed that the externals are the same as before: the cause in question, then, not being obtained from without, must belong to the seat in which its effect is contemplated. If this cause before resided in a structure in which it did not display itself by effects, we can express its conditions only by saying that it *was* latent or passive, and afterwards comes to be inferred from its effect, or is active. We are not yet arrived at the origin of these processes.

§ 19. By saying that a cause is latent, we intend that it is in a state of combination in which it is not cognizable to our faculties; if a cause is in this state which we call latent, or is better expressed as *passive*, why, it must be inquired, is this passive condition changed? We here perceive the necessity of a causation previous to that by which an effect is produced by a latent cause.

§ 20. This remoter causation admitted, we are still as far from arriving at an *origin* of these processes; for every change must be preceded by another, and the series, as well in the limited subject which now occupies our regards, as in the universal scheme, must be infinite. We see a certain state of constitution is preserved for many years; at some period this state is altered, predisposition changes into disease, disease into death. In our physiology we have remarked an order analogous in its kind, and some examples still more striking may here again be mentioned. We perceive, in the growth of the fœtus, how, from a mere speck, bones, muscles, arteries, veins, nerves, &c. are produced. We see the being thus made, afterwards preserving a form, without any striking change, except the gradual increase of the structures: after the lapse of years, the attainment of puberty, glands secrete which never secreted before, and the general changes which happen at this period mark an important era in the history and existence of the person.

§ 21. These are instances of that complication which has been remarked to arise out of only two modes of causation. Causes are infinite: their modes of producing effects have been said to be only two by addition, &c.; they may be still further simplified: essentially, the mode of the operation of a cause is, that it exists;

it can do no more, it has no virtue to be what it is not. But causes have relations by which they join their existence, and each being a different form, their distinction is lost in this union, at least to our perception. The study of these relations forms the principal business of philosophy; and as knowledge of individual causes must precede the steps by which we investigate their relations, hence the complication which in this our present subject belongs to the analysis of the causes upon which phenomena depend. We are professedly ignorant of the most essential of these causes: and where this particular knowledge is denied us, we can only state our difficulty, and, with a view to future progress, shew its conformity with those general principles which must direct our research in this, as well as in all other instances.

§ 22. If a gelatinous bed is converted into muscular fibres, if cartilage is converted into bone, if the amazing structures of a perfect animal are developed to this state from a nucleus to all appearances without a character, if in the course of being new functions arise, if the functions which maintain this fabric become disordered and finally cease, and this piece of anatomy fall to decay, we can regard this series as the result only of properties and relations which are disposed *for progressive change.*

§ 23. *Progressive change is accomplished by reiterated causation. If a thing preserve an uniform identity, it does so because it is surrounded by no agents which are so related with as to affect it; if a thing is once changed, and then preserve its new form, it is that it is exposed to the operation of a related agent, and that the form which it assumes in consequence ceases to be related with the existences which surround it; if a thing suffers one change and then another, and a third, through a lengthened series, it is because each successive form of existence has a causative relation with other forms.*

§ 24. To apply these principles first to our physiology. Properties are related with a nutrient material containing infinite constituents, so as to separate or produce from it a gelatinous fluid; the properties which produced this fluid belong to the organic spirit, and constitute one state of it; this state is a form of existence which is related with surrounding agents, so as to suffer a change; this new condition is again related with other constituents of the material, and the end of this new relation, thus established, is, that the properties producing jelly, having changed their state, cease to separate this fluid, and produce, conformably with their present or new state, the aggregation perhaps of cartilage. These processes are repeated, and cartilage gives place to bone, and so of all the other structures.

§ 25. But we observe instances wherein this progression appears to be interrupted: the subject or the particular effect which we contemplate appears for a time to be at rest, and then at perhaps a distant period it assumes a change. We may trace the stages of conversion in the growth of the fœtus, and we can

observe how one form succeeds to another; but in these changes at remote periods (as in the attainment of puberty, or the occurrence of spontaneous disease) a process seems to have *commenced*, without any preparatory acts or connecting links. What is the explanation of a change of this sort? If this change is not produced by foreign externals, which we have assumed, it can happen only by that progression the nature of which has been just explained. If the precise subject or effect which we regard preserve its identity and then alter it, apparently under habitual circumstances, it is because changes are going on among connected agents which have no relation with the subject of our regards; until they have arrived at a particular state, viz. one in which they hold a causative relation. Thus, it happens that we suppose a process to *originate*, without the preparatory changes, merely because we are regarding one set of phenomena, while changes which come in time to affect these phenomena (and then it is that change is first perceived) are going on among connected properties.

§ 26. The growth of the body, and its changes, are similar to those of the mind, and the former may be further illustrated by what is more familiarly observed of the latter. The mind of an infant has been said to be a blank tablet: this is said in the way of metaphor. The mind in this early stage is a state of properties which has certain relations with the external world: the effect of these relations is, that the mind which was a *predisposition* is made by a common act of causation another identity, by the introduction or combination of additional causes; or becomes, according to common metaphorical language, stored with ideas, which again are related with each other, and help to accomplish the phenomena of association and inference, &c. Thus much for our present purpose: we see this mind by degrees making its acquisition of knowledge; as its identity changes new relations are opened, its notices are first on one set of objects, having attained the state which these constitute its notices are extended to another set of objects, these familiarized, its *predisposition* is again a new one, and it takes cognizance of things to which it was before blind or unconscious. By this progression, similar to that which all nature observes, one acquisition disposes to another, materials are accumulated, new associations arise, thought improves, taste is developed, and the interchange of agencies in the constituents of mind itself or its affections, by relation with the external world, are limited or extensive; confined to the sober walk of industry, plodding upon a business or upon domestic concerns; or, if it is so prepared, taking a wider range; or soaring perpetually some bold flight of genius. These processes make a growing predisposition, which can never preserve one given state, because the constituents of mind being related, and these relations being further extended to all the variety of externals, progressive changes must succeed; and these are rapid or slow, not necessarily in their own nature, for in this they are perhaps uninterrupted, but in the *apparent*, and in the *imperceptible*

conversions of related beings. If, then, it be asked why the testes secrete at 16 and did not secrete before; let it be asked as a parallel, why a person understands a certain proposition in Euclid at 16, and did not before? The reason is the same: a progressive change or a series of causation leads up to this effect. The character of the changes of mind, each particular phenomenon which it exhibits, is that which it is made by its own constitution or by an external related agent; each change, each phenomenon, whether belonging to the physiology or disease of the body, is produced from similar sources. We have then to discriminate between those things which proceed from the *original constitution,* or parental radicle, and those which are to be attributed to the influence of externals.

§ 27. It is demonstrated by our anatomy, that the first perceptible original of an animal (as of a man) is an insignificant aggregation of matter, possessing no sensible arrangement, but endowed with certain properties. This radicle suffers or exhibits the numerous changes which are just represented; but these changes do not occur among its own inherent properties, but in obedience to a relation which subsists between these and certain external properties and substances. The question here then to be discussed is, what share have the properties of the ovum in the subsequent changes which it undergoes?

§ 28. There are two modes in which the properties of the ovum may contribute towards the conversions which occur in its development. 1. The first state of the properties of the ovum may be so related with the external as to produce, in conjunction, one change; this change, or this new state, may open a new relation with externals, and produce another change; and so on through a series: in this way, the properties of the original predisposition, or the ovum, may have with respect to subsequent phenomena the importance only of remote causes, and the series and nature of ensuing changes, though taking their determinate character from this first predisposition, may concern principally the accession of properties and substances obtained from the external world. The 2nd mode in which the original properties of the ovum may operate in regard to ensuing changes is by a *direct causation* with respective phenomena; as if that progressive change which has been described went on in properties originally belonging to the ovum, and as if every new change resulted from the development of a latent property, in the manner explained. The latter of these has been preferred (in the instances there cited) in our section on the constitution of the ovum. As we possess no criterion by which we may discriminate when, in particular instances, either of these modes obtains; as also it is probable that in all instances these orignal and external properties are mixed in causation, and the more especially as in our present state of knowledge we may rest satisfied with a deduction from alternatives; on these accounts it appears superfluous to state the objects with which an inquiry for such a criterion might be con-

ducted. Let us therefore, as such is the highest success to which we might aspire at this time, be contented to state our deduction, or corollary, respecting the share which the first properties of the ovum have in subsequent pheuomena, whether of health or of disease.

§ 29. If the original properties of the ovum have, with respect to the subsequent processes, the importance only of remote causes, then the nature, order, &c. of such changes are determined by these properties of the ovum, although the respective effects which occur in catenated causation may be constituted by properties acquired from the external world. And whatever differences might occur in the development of two animals of the same species, they are to be referred to an original peculiarity in the respective ova, which, being differently constituted, run through a series of different relations, and of course exhibit different phenomena. If the processes of development, &c. are to be attributed to progressive change, going on between properties originally possessed by the ovum, each property, as it passes from the latent to the active form, producing as a constituent its own effect, then also the phenomena of development, conversion, &c. are to be attributed to the original constitution of the ovum: in their first case this constitution is preparatory to subsequent occurrences; in the second case they are contributary, or have the importance of a real cause, which is that without which the effect cannot exist. We have, it is said, no satisfactory criterion by which either of these alternatives may, in particular cases, be positively adopted.

§ 30. We observe in the intellectual system, that its phenomena concern chiefly the *acquired properties*, viz. the *ideas* which are acquired, or formed with the help of the intellectual predisposition. We see also that the information of the mind and its peculiarities in individuals, take their determinate character from the intellectual predisposition; it is this which directs and produces all the variety of opinion, and the infinite motives to action in different individuals, surrounded by the same externals, or existing in nearly similar circumstances. Yet here there is similitude in the offspring to an original in the parent, as in the corporeal phenomena. The testes begin to secrete at sixteen; a person becomes consumptive at five-and-twenty, whose mother died of consumption perhaps at about the same age; a person at three-and-thirty becomes *deranged in mind*, whose father or grandfather was deranged at about the same period. Here it would appear, as if properties, in all these cases, which could specifically determine these events, belonged to the ovum, and remained latent until they were developed by that progressive causation which we have attempted to describe. On the other hand, we know that insanity engages principally the acquired properties of the mind or its ideas; for the form of insanity may consist in disordered judgment or inference, and perhaps only on one subject, the act of which consists in the comparison of ideas, from the analogy of which an inference is made: or the form of insanity may

be one of disordered association only; comparison, or association, of what? of *ideas;* or of that which is not obtained from parents, or possessed by the ovum. It is perfectly clear, that if a man were born of mad parents, and had in ever so strong a degree the hereditary taint, he never could have either of the above forms of insanity, viz. of disordered comparison or disordered association of *ideas,* if he were so circumstanced from his birth as to be precluded the acquisitions from externals, as, if he were enclosed in a dark room and never permitted to hear an articulate sound. Yet in these forms of insanity the predisposition is hereditary, although the form itself is principally constituted by the acquirements from without, and dependent perhaps upon education and a long train of connected causation. In this case, although the acquired properties or ideas have a principal share in immediately constituting the insanity, and in determining the consequent acts of volition, yet we must suppose the predisposition to ideas to have a share, or in fact, if it is a principle of consciousness, to be the basis of their individual existence. Here, then, we may look for the cause, or a cause, of the insanity; and as the insanity cannot arise out of the mere predisposition, but is principally dependent upon relations of ideas, so in this, as in the corporeal instances, we perceive the probability that the original and the acquired properties are mixed in the causation of progressive phenomena; and in this case too, as in the other, we perceive the impossibility of pronouncing, such a share have the original, and such the acquired properties in these occurrences. We must for the present be content with our alternatives.

§ 31. From this view it appears that we cannot fix a period to the commencement of the processes which are preparatory to disease; the necessity of a progressive change, leading up to this state of disease, is demonstrable; and, with respect to the causes which constitute the disease, we cannot lay down any general criterion by which to distinguish whether they belonged to the ovum or whether introduced from without. In cases of contagious and infectious disease, &c. we know that a cause is obtained externally; but the share of this cause and that of the original properties, as we may conjecture that they produce effects in conjunction, we cannot even here discriminate.

§ 32. That state of the properties which is the stage of progressive change, immediately preceding disease, is called *predisposition; any change,* the *tendency* of which is finally to impair functions, &c. may be said to comprise a diseased state. But there is convenience in the distinction between predisposition and disease: according to our notion of the difference between these two, predisposition is a change of the state of perfect health which *does not produce symptoms;* disease is also a change of the state of health, but it is manifested by symptoms: the former change is not related with our faculties of perception, &c.; the latter change is related with our faculties of perception. The most healthy state may be

predisposed to disease, because there is no state which does not somewhere find a relation capable of producing change with some or other external. Thus all bodies are predisposed to disease and death by the relation of their properties with arsenic; nearly the same thing may be said of the plague, of morbid poisons, &c. But it is proper to confine the use of the term *predisposition* to those states which have a relation productive of disease with natural and habitual properties, or with those to which the same subject at other times, and the rest of the species, may be regularly or occasionally exposed without the supervention of disease.

CHAP. II.—*Origin of Disease in one Seat.*

§ 1. DISEASE (or symptoms) may commence in any given seat from a progressive causation which is uninterrupted, or from preparatory changes which have rested in the state of predisposition; and then a new causation is begun, which terminates in the exhibition of symptoms, or in death. By these principles the question must be answered, why does disease commence?

§ 2. When the changes which terminate in disease are uninterrupted, each internal change is a predisposition, *which is related with existing causes.* When one series terminates in a predisposition, the progression towards disease is renewed, or the state immediately established, only by the operation of causes which, though perhaps common and natural ones, did not obtain when the former changes rested in the state of predisposition. This latter has been exemplified in physiology, it is necessary to illustrate both a little further by a short comparison with the histories of disease.

§ 3. In our example of consumption, we have supposed no external assignable cause; but admitting that such a cause did obtain, its first operation is not to establish the symptoms which identify the disease; that is, the lungs do not at once, by a casual exposure to cold, become ulcerated, &c.; but a trivial symptom, as a slight cough, or some change preparatory to the complete establishment of the disease, is the result of the operation of this cause. From this change the series is uninterruptedly progressive; for the *relation is constant* between each change and the existing causes. This is an instance of the production of symptoms in an uninterrupted series. The history of predisposition might be different; it might consist of interrupted gradations, which are next to be exemplified.

§ 4. A woman might have a small tumour in the breast; it might remain, without change for many years: this tumour has formed by a train of causation indicated in the preceding pages; this series has rested in a state of predisposition to the condition which the tumour afterwards assumes; it rests in this state, because its constituents no longer hold a relation of change with existing causes. If this state is altered, it must be from the influence of some new cause; this cause may be produced from change going on internally among *connected agents,* which having attained a certain state, may

then become *related agents.* Thus, while our tumour is at rest, suppuration might take place in the axillary glands, and the tumour might disappear, while the contiguous parts are running a long course of disease; or, the tumour being at rest, an habitual diarrhœa might occur, and the tumour disappear; or the tumour might remain at rest until the cessation of the catamenia, and then it may begin to increase in size, become painful, and finally degenerate into cancer; or, by some accident, the tumour in its state of rest may receive a blow; it may in consequence inflame, suppurate, and disappear; or it may become malignant from this cause. This illustration is sufficient: the axioms I mean to establish, with respect to the general history of causes in the production of disease, are,

1st, That every primary, spontaneous, disease is produced by progressive change in the constituents of its seat.

2nd, That this progression may be interrupted, when the present state ceases to find a causative relation with existing causes.

3rd, That if the progression of change is resumed, it is because new causes obtain a relation which did not before exist with the constituents of its seat.

4th, That these new causes may come to produce change in a given seat, either from progressive internal change among connected properties, or from exposure to an external cause which is related with the present predisposition of the seat; these might be complicated.

§ 5. If then we would trace the history of spontaneous disease, we should indeed, although the general laws are so few, undertake a perplexing inquiry. Say a tubercle forms in the lungs: why does it form there? the part, it may be said, becomes thickened by coagulable lymph, which then becomes organized, grows, suppurates imperfectly, &c. Why was the lymph thrown out? from inflammation; why did the inflammation occur? excited by cold; how came the part predisposed to such a relation with cold? it has *somehow* attained such a state. Now my abstract refers to this word "somehow;" and if this somehow is to be answered, the only reply that can be given will be found in the above propositions, which I have called axioms. To leave then this subject of the manner in which disease begins, and without taking any further with us the incumbrance of these views, we will simply say, when disease occurs spontaneously without any assignable external cause, that it happens from the development or operation of latent causes, about which we have been of late so busy; and that when disease happens from an external assignable cause, which does not produce the same effects in others, or in the same individual at other times, we will say that a predisposition existed to the operation of such cause, of the nature of which predisposition also enough has been said in the way of indication.

§ 6. We have assigned in our physiology three sets or classes of properties which concur to constitute an animal, viz. those belonging to the vital, the chymical, and the mechanical departments.

The phenomena of disease exhibit deviations from the state of health in each of these departments. We have to determine in this place, whether a predisposition, and then the symptoms of disease, might *originate* in either of these; and if so, we have to suggest a method of discriminating the instances, or whether the origin of predisposition and disease belongs exclusively to the properties of one class, by which those of the others are influenced consecutively.

§ 7. We will select as an example a disease which appears to consist chiefly of a change of structure, or of some mechanical impediment; supposing that if disease does not originate in the structure, in those instances in which the structure is visibly changed, we are not to expect an *origin* of disease in the mechanical department in cases in which this order of components does not sensibly participate. We will take for example a scrophulous abscess, and trace its history with the above view in our analytical way.

§ 8. Why is a collection of matter formed? it is formed by an inflammation of a peculiar sort, &c.; matter is produced (says our reply) by inflammation: the causes which constitute inflammation, and which produce its phenomena, belong either to the vital, chymical, or mechanical properties, or else these concur. To proceed: pus is a change of the fluids belonging to the seat in which it is produced; why are the fluids changed? Supposing the fluid which furnishes the material for the conversion to be blood (though most probably it is not blood), supposing the fluid to be blood, why is the blood of a part changed? say (arguing for the chymists) spontaneous decompositions and combinations take place in blood, the result of which is the formation of pus; why do these decompositions, &c. occur in blood? from some previous change, for they would not spontaneously occur in blood healthily disposed. But the blood in this part where pus is formed is the same, from the same vessels, and no fixed or specific quantum of blood, as circulates elsewhere. This part must then have properties, holding a relation with blood, different from any to which it is elsewhere exposed. To these properties, then, and not to the mere internal causation of blood itself, is to be attributed the conversion of blood into pus, or perhaps more correctly the formation of pus from blood. These properties we are to inquire after.

§ 9. These properties belong to the structure forming the seat of the production of pus: are these efficient properties of a chymical kind? we have no reason to think that they are; but granting it, which is the most that can be required, if these properties are of the chymical kind, how came the seat to be possessed of an unnatural or a diseased chymical constitution? Here we must recur to our physiology, and ask why there are any chymical constituents at all in this seat? They are held together in a forced allegiance during life, and by life; left to their natural propensities, they separate and dissolve into their elements. It is to life, then, or the properties which constitute it, that the chymical constituents are indebted for their local existence; these chymical constituents are formed from

a common material, from the same material as a tree is formed. If, then, their state is *peculiar* in the several instances, the source of this peculiarity is not in their *common origin*, but in *related properties;* these are the properties of life.

§ 10. If, then, the properties of life produce chymical combinations conformable with their own nature, suppose a deviation from a given or natural state to take place in the chymical properties, it must arise either out of the nature of the first chymical disposition, as formed from the spiritual properties, or from a new state of the spiritual properties; in either case, the *origin* is alike in the state of the properties of life.

§ 11. We cannot quote a more striking example of mechanical disease than a stone in the bladder; although in this case the chief phenomena of the disease are produced by this mechanical cause, we shall not find that the *origin* of the processes by which the calculus was formed, belonged to the mechanical department. The stone is formed, it is said, by excess (or something else) of uric acid; what makes the excess of uric acid? say, merely by way of defining a seat, that it arises from a faulty secretion of the kidneys: now the blood in the kidneys is a common material (or if the seat is elsewhere, we must still trace up to a common material, even though we should arrive at the digestive organs); if from this *common material* a product arises which is *peculiar*, we must seek for the cause of the peculiarity in the related properties, and not in those which are common. The *related properties* in this case have their seat in the kidneys, and belong to that class without which urine would not be secreted at all. If, in this case, instead of saying that these related properties are vital, we say that they are chymical, we do but defer arriving at the result of analysis: for if the chymical properties are peculiar, they being first *made*, and afterwards *maintained*, and *renewed*, by the *related ones* which are spiritual, we then assign to these latter a *mediate*, instead of a *direct agency*.

§ 12. Thus it appears that the *origin* of change, even of that progressive kind which has been indicated, is from some property of life, which must be peculiar in every case. But in the course of a series of progressive changes either the chymical or the mechanical agents may operate as a cause, by which either the changes of predisposition are multiplied, or perhaps the phenomena of disease produced.

§ 13. The properties of the chymical or the mechanical departments may become re-agents: their varieties are first produced, either by an affection of the spirit by a foreign external, or by an original peculiarity of the spirit, under a relation with common or natural externals.

§ 14. However complicated the re-agencies of these three departments might be, in order to determine the share, or how much, or what phenomena, are to be attributed to the agency of life, or the organic spirit; we have only to ascertain whether the phenomena in question are peculiar to the living state; for whatever the origin

might be, whether in the seat of the symptom or in a related one, whether in the first formation of the ovum, or in a subsequent spiritual change; or whether produced by a chymical or mechanical cause, which being itself an effect, in turn becomes a cause; whether arising from internal causation or produced by a foreign external: whatever may be the process by which a symptom takes place, *as much is to be attributed to an altered condition of the spirit as cannot take place without it.* Thus, in an inoculated disease (as the small-pox), say a peculiar chymical substance is introduced into the body whose effect is to produce eruptions, &c.; these eruptions are formed by a suppurative process: now although the cause, for the sake of the argument, may be granted to be chymical, yet would not the *animal phenomena which succeed to its introduction* take place unless the properties of life were under a state of preternatural affection. It is the history of the spiritual properties which I wish chiefly to trace; and as every form of disease is peculiar to the living state, so the laws of the properties and affections of life admit an analysis which will refer to the general character of disease; and this analysis must be principally founded upon our physiology.

§ 15. Having shewn in part the importance or share in disease which might be attributed to the chymical and mechanical departments; having shewn that *spontaneous change* in the properties of these departments is always secondary, but that they might become re-agents; I shall now proceed to speak of disease, as more exclusively concerning the state of the organic life; and the future employment of the term disease will be understood with the qualification here hinted at.

CHAP. III.—*General Nature of Disease of the Spirit.*

§ 1. IT has been remarked, that the most intimate knowledge to which we can arrive of the nature of disease enables us to say only, that health being a given state of the principle of life (or of its properties), disease is a change or deviation from this state. We cannot specify in what the identity of health consists, or in what the deviation from this state consists, because in neither case do we possess the faculties necessary for such a specification; or, in other words, we are not qualified to take cognizance of the objects.

§ 2. Disease is transient, continued, or permanent: upon what laws does its *duration* depend?

§ 3. Disease first depends upon its causes: the causes of disease, with reference to our question, are of two kinds: 1st, those which being related with the spirit have the power of affecting it, and producing disease as often as they are communicated, or as long as they continue to reside with the spirit; 2nd, those which may modify for a time or permanently the identity of the spirit, even though the operation of the primary cause should have ceased. The state of the spirit produced by the first class of causes is not an assimilating one: the state produced by the second is either maintained by assimilation or runs into a succession of modified states, each capable of assimilation.

§ 4. 1. Life, as explained in our former sections, is no fixed sum, but is produced from its elements, unites its elements, contained in blood, and immediately changes its form. In this way a similitude is perpetuated, although the quantum existing at a subsequent, is never the same as that which existed in a preceding moment. If, therefore, the identity of life be affected by a cause (as one producing disease), this cause must be repeated or renewed for each successive quantum of life, unless uniting with life it is renewed by assimilation, or, in other words, unless it finds its similitude in arterial blood. If a cause produces temporary change, which endures only so long as it may be supposed to continue, or as is less equivocal, if the effect ceases as soon as the identical cause is removed, we then infer that it has not occasioned a disordered assimilation of the spirit.

§ 5. To illustrate this class with an obvious example: suppose the brain to be compressed, the properties of the brain which contribute towards the function of respiration would by this cause be modified or disordered, or even their office might be suspended. A healthy state of these properties may be immediately resumed as soon as the compression of the brain ceases.* The efficient cause, whatever it was, which in this case disturbed or altered the vital properties of a sphere, had no assimilating relation with the material: if it had, the state which was produced by the operation of this cause would have been continued after the causation occasioned by the pressure had ceased. Thus also (though less obviously) wine, brandy, &c. taken into the stomach, produce a disordered state of the properties of life, perhaps in many spheres, which disordered state continues as long as the quantum of these spirits, or of the related properties which they contain, may be supposed to last. We find that their effects endure in proportion to their quantity, provided they are not, in the examples, rejected by vomiting, &c.

§ 6. To this class also belong many of the phenomena of related disease. Thus a disease set up in one organ or part may affect distant ones, which either do or do not, during health, afford evidence of an intimate connection: thus the local injury incident to a fracture of the leg will perhaps raise the action of the heart to 130 beats in a minute; when the violence of the local injury has subsided, the heart will resume its former action, which might be at the rate of 70 beats in a minute. Thus, also, irritation of a nerve will produce convulsions, which cease as soon as the irritation is discontinued: thus, a blow on the head will produce vomiting, the properties engaged in which action do not perpetuate their state when the brain has recovered from the effects of the blow, in which primary organ with respect to the duration of the effects of the injury the same thing is also to be remarked: thus, also, the irritation of a stone in the bladder will maintain a chronic disease of this viscus as long as the stone remains, and the irritation of it will perhaps produce a wasting and hectic state of the whole body, which effects cease when the cause of the disorder is removed. To this class also belong the great bulk of medicinal preparations: purgatives, emetics, diuretics, sudorifics, &c. produce respectively, a state of the local properties conformable with their character, which state lasts so long as the cause which produced it resides with them. The reason why these effects do not outlive the application of their causes respectively is, that neither are these causes assimilated from arterial blood, nor do they lead to processes of causation which produce a modified assimilating spirit.

§ 7. 2. We have no means of discriminating, in all examples, when causes of disease unite with the spirit, and finding their similitude in arterial blood, are maintained as the spirit itself is maintained;

* An experiment of this sort, with such a result, has been made on the human subject, in a case in which a large removed portion of the cranium has never been reproduced. The compression was made with a handkerchief.

that is, we are not in all cases able to pronounce when disease is continued by assimilation of the external (for instance) which produced it, and when disease is continued in consequence of a causation among the properties of the spirit, in which the primary cause (the external) has no subsequent share.

§ 8. That some causes of disease have an assimilating relation with blood is proved by the phenomena of the morbid poisons: thus the matter (as is said) of small-pox produces matter endowed with its own qualities; it is not that there is any relation between the small-pox matter and blood, by which a similar pus is produced in the inoculated person, for inoculation will not produce small-pox in the dead subject; but it is, that there are properties in the virus which unite with the spirit, assimilate similar properties from blood, and these holding the same relation as their prototypes with the constituents of blood, produce and ally themselves with the same secretion. The phenomena of syphilis, perhaps the plague, and most or all of the causes of infections or contagious disease, are capable of being continued by assimilation. Assimilation, however, is not the only process of these causes: in some part of their series of consequences they fall under another department, expressed in the definition of our second class.

§ 9. But although assimilation, or the production of a likeness from arterial blood, is sufficiently clear in the above instances, it is not so in others. A person, from exposure to an easterly wind, may get an attack of pneumonia. Can we say that the properties of this wind, which affected the spirit, are retained or united with it, and, finding their similitude in arterial blood, produce the phenomena of continued disease? or, if a person receives a blow in the breast, in consequence of which a tumour forms, which in time becomes schirrhous, can we say that the modified assimilating state of the spirit, necessary to the disease, is maintained by the properties originally imparted by the cause of injury? we should exceed our warrant if in these and in similar cases we were to pronounce an affirmative. Any argument derived from predisposition is here nugatory: for if it be said, these causes do not assimilate, because they do not in general produce such effects, it may be replied, if they have no assimilating relation with the state of perfect health, it does not follow that they should have none with the state of predisposition; at the same time their producing such effects with the aid of predisposition, does not prove that they do it by the process of assimilation, which we have described.

§ 10. When the evidence does not furnish a fair conclusion, we are warranted only in defining the facts: certain causes, such as those above adverted to, produce continued disease, and at the same time produce their own likenesses, or similar properties. Other causes produce continued disease, which remains without a repetition of the causes; these latter do not obviously assimilate, but they produce internal causation or progressive change, which terminates in recovery or death. The nature of the processes which regulate occurrences is to be further considered.

§ 11. External causes which are common or habitual, as we have seen, never produce disease without those preparatory changes which establish the state of predisposition; and with the aid of this predisposition they do not at once establish the disease which follows. A person during the exposure to cold may feel only a slight shivering: pneumonia or fever may succeed at a short interval after the exposure. Hence, it is not the property of this cause, viz. cold, to *constitute* the subsequent disease, nor can it, unless it assimilates, have any immediate share in the state of disease; and whether it assimilates or not, the disease is established only by progressive causation or by successive changes.

§ 12. Predisposition then, as belonging to the department which we are considering, is one state (a modified one in comparison to the state of health) of the organic spirit; the predisposition is produced by changes of the latent properties of the spirit; the condition thus produced is so related with an external, as to suffer, upon exposure to it, another change which exhibits symptoms; this change also, or this state, is made by latent properties, in which the external has no share as a *cause* (according to our definition of a cause) unless it endures with the spirit, and is renewed like the spirit as fast as this latter passes away or dies.

§ 13. This state, produced conjointly by predisposition and exposure to a related external, is one of disease: it may occur without any assignable external cause, in the way before described. The identity of the diseased state is dependent upon the causes producing it, which cannot be defined because the state itself is not susceptible of analysis. Disease being established, its present form may endure for a time with little variety, or it may run through a series of changes, or it may occupy only one seat, or it may be extended to others, or diffused over the whole system.

§ 14. During all these changes life still maintains itself by assimilation: that is, life admits all this, which is a considerable variety, and still preserves its character as an assimilating principle. The identity of this principle at any time or in any stage is dependent upon the combinations of its own properties, and its participation of related ones, whether external, derived from a related sphere, or existing in the blood. Let us now return to our example of a disease, that of phthisis pulmonalis, and see how far these doctrines agree with its phenomena, or elucidate the minuter history of its formation.

§ 15. Predisposition, established by that progressive internal causation before described: this predisposition consisting of a modified or peculiar state of the spirit; this state of the spirit has one seat in the structure of the lungs; this state of the spirit is one which is related with a condition of the atmosphere; the effect of this relation is perhaps to produce inflammation; the tendency of this inflammation is governed by latent properties, which belong to the spirit: by these it is decided whether the inflammation shall end in resolution, or whether it shall advance towards a quick or slow

suppuration; by the development of these latent causes, by those varieties of combinations which make progressive change, all the circumstances of this local disease are decided; by these it is determined whether an imposthume forms, which ulcerates speedily, and discharges its contents; by these it is decided whether the bursting of this abscess shall be followed by re-generative processes, by which health is re-established, or whether ulceration is extended, or whether a slow inflammation remains, which produces further thickening of the structure; by these it is determined, whether such thickened structure, or the adventitious matter composing it, shall be absorbed, or whether the suppurative processes shall be renewed; by these the quality of the pus is determined; by these scrophulous matter may be produced, or phosphate of lime may be deposited. The predisposition is perhaps not originally confined to this structure; the properties which animate the heart may also have attained a predisposed state; this state may be attained by complex relations; it may be attained by progressive changes of the assimilating life of the heart; or the original seat of change may be in the sources of the regular dependent properties; or the heart may be affected by those of the occasional kind, as if the disease of the lungs communicated properties to the heart which raised its actions to 130 in a minute: this, however, would not take place except the state of the spirit which governs the movements of the heart was a peculiar or predisposed one. By these latent properties, also, is determined the fate of the arteries, in the seat of the local disease: their cohesion is firm, and they retain their blood; their state is otherwise predisposed to rupture, and this prevails either in the minute branches or in the trunks, and we find among our symptoms small expectorations of blood or great hemorrhages. By these the changes of the chymical and of the mechanical circumstances of the structures are regulated; by these the changes succeed which result from those modifications of the structures; to these are to be assigned the phenomena which are produced by the new relation opened between a modified state of the spirit and a modified state of its chymical and mechanical alliances. By these the sphere of disease is settled, whether confined to one seat or extended to others, and to what others it is extended; by these, latent changes proceed in a series; by these, phenomena, which we call symptoms, are every now and then exhibited, as the sensible tokens of these latent changes; by these it is decided whether life remains permanently a modified principle, compatible with health,* whether the identity of health is restored, or whether the series of progressive change terminate in producing a state of the spirit in which it can assimilate no longer, or in the condition of death.

* The small-pox, and those diseases which can occur but once, are instances of the production of a permanently modified assimilating principle, without interruption of the functions and phenomena which characterize health.

§ 16. Although the spirit may be said to be liable to change which respects either its combinations or its quantum, we can scarcely insist much upon such a division, for that which we may attribute to excess or deficiency may arise only from a different disposition of its properties, and possibly changes in the combinations of properties may occur from defect or excess of quantity. These latter states must, however, be dependent upon the blood, and the blood being dependent upon the preparatory organs, and the phenomena of these organs being regulated by the disposition of the life that resides in them, the phenomena in question, even the defects or excess of the quantity of the principle, may come ultimately to be referred to its identity or disposition in some or other of its seats.

CHAP. IV.

Disease of the assimilating, of the regular dependent, and of the occasional Properties of Life.

§ 1. THERE are but few (perhaps not any) examples of disease which is confined wholly to one part. There are many instances of disease of one part, in which the organic system elsewhere does not perceptibly suffer: but these are attended with pain or disordered motion, which is sufficient to prove an extension of the diseased state. In the organic system however a person may have an ulcer in the leg, or a tumour upon the shoulder, or an herpetic disease upon some spot of the skin, or a stricture of the urethra, &c. without any sensible derangement of the same system elsewhere. But even in these instances we cannot prove that the change is entirely local, unless it may be shewn, 1st, that the natural condition of the seat is not a dependent one, by which disorder might originate in another sphere; and, 2nd, supposing the disease to originate in its apparent seat, that no other is so connected with it as to participate in its modifications. But if it is possible that any part should possess only an assimilating life, that no other part is dependent upon it, and that the condition of disease does not open any new or preternatural relation, then it is possible that the assimilating life of such part may become exclusively diseased by that progressive causation which has been described.

§ 2. It happens however in most instances of disease, that this state prevails in more than one seat. In such instances these two alternatives are to be discriminated: 1st, whether the diseases occupying different seats are not independent of each other? 2nd, whether the primary *produces* the secondary disease?

§ 3. If in the course of a fever an abscess should form in one axilla, and a week afterwards an abscess should form in one groin; if the eruption of the small-pox should appear first in the face and then be extended over the whole body; if a tubercle should form in the liver, and a month afterwards a vomica should burst in the lungs; if a venereal ulcer should form in the throat, and six weeks

afterwards a node on the tibia: we should scarcely in these (and there are many such) cases assert that the disease occupying the first seat was the cause of the disease occupying the second.

§ 4. But if one half of the body should be paralyzed by the rupture of a blood-vessel of the brain; if vomiting should succeed to a blow on the head; if disordered respiration should succeed to the operation of a cause of pressure on the brain; if atrophy should succeed to disease of the mesenteric glands; if the secretion of a gland should be suspended during an inflammation of it; if convulsions should succeed the irritation of a nerve; if paralysis of the sphincter of the bladder should succeed to an injury of the spine, &c.: we have no hesitation in these cases in affirming that the primary is the cause of the secondary affection, because we know that the healthy state of the properties engaged in the secondary, acknowledge the *regular dependent relation*, with those engaged in the primary seat of affection.

§ 5. Again, if vomiting should succeed the formation or (introduction) of a calculus in the gall-duct, or to the passing of a calculus along the ureter; or if a pain in the shoulder should succeed an inflammation set up in the liver; or if hernia humoralis should succeed to an affection of the urethra, perhaps produced by an injection; or if tetanus should follow a punctured or lacerated wound; or if pain in the breasts should succeed conception, &c.; we have in these cases no hesitation in saying, that the secondary is *produced* by the primary change.

§ 6. These are examples of the classes of related disease. Disease of one part, or one state of disease, might produce another: 1st, by disturbing an habitual dependence; and, 2nd, by the influence of an *occasional* cause. The first is illustrated above; as if an injury of the brain should paralyze nerves whose functions are dependent upon the brain, or as if respiration should become laborious, or perhaps cease, by the operation of any cause of pressure upon the brain, &c. The second is illustrated in those other examples, in which a relation is exhibited under circumstances of disease, which was not manifested as one of dependence for a natural office, during health.

§ 7. The affection of a dependent seat in consequence of a disordered state of the seat from whence its functional properties are derived, is by no means a regular occurrence. We know that there might be a violent pain in the head, a throbbing of all its vessels, as if the whole brain was violently disordered, and yet the function of respiration, which depends upon the brain, may be but little or not at all interrupted; at the same time, a slight pressure upon the brain shall impair or prevent ~~these~~ this dependent function~~s~~. The reason is, that properties are not indifferently related with any cause of disorder: but their relations are precise; as, properties of the brain animate the organs of respiration, these properties related with the agency of pressure, not related with causes merely producing pain or even inflammation; the dependent function,

impaired by the former, because the former is related with the properties engaged in the dependence; not related with the latter, because although they produce a certain affection of the seat of the properties which animate the respiratory organs, they do not produce a change in the nature and relations of these properties, to expect which would be like expecting that paralysis of nerves should not occur from pressure upon a part of the brain, because it still retains some properties of life.

§ 8. It has been stated that related disease happens in two ways, which may here be repeated: 1st, by disturbing an habitual relation of the *regular dependent kind;* 2nd, by a new relation which is opened between parts not before connected by intercourse of function, in consequence of a new condition which one of them has assumed; it has been stated (and examples given) that disease might occupy a succession of seats without the existence of any causative relation between them. It is necessary before we proceed any further to inquire after the method of distinguishing between diseases which, though occurring in a series, are independent of each other, and those in which the subsequent, is produced by the preceding disease.

§ 9. In making this distinction we are liable to frequent error: the only grounds of the distinction, however, are as follow. Mere succession, as has before been insisted, can never prove causation: but it indicates causation, from the analogy of succession to those palpable instances of causation in which the dependence of the effect upon the assigned cause may be proved by the result of analysis and of synthesis: of taking away (or witholding), and of combining the causes. Succession then, upon this ground of analogy, which has been more fully explained, may *indicate* causation; and yet we do not suffer every instance of succession to suggest ever so faintly an inference of causation.

§ 10. The succession of an effect to its true cause is *invariable:* from analogy in this respect, we infer positively the operation of a cause in all instances of *invariable succession;* thus day and night *invariably* succeed the presence or absence of the sun. But we presume still further upon this analogy, we infer the operation of a *cause,* when the succession of the same consequence to the same antecedent is *frequent,* but not *invariable;* thus, an ounce and a half of laudanum taken into the stomach will commonly, but not always, produce death; we have no hesitation in assigning the laudanum as the *cause* of death, in those instances in which death takes place, notwithstanding there are other instances where the obvious circumstances are alike, in which it is not followed by death. *Invariable succession* bears so strong an analogy to causation, that we scarcely suspect the possibility of our being deceived in an inference grounded upon it; and yet we do sometimes make a false inference founded upon past invariable succession, as is proved by additional, or subsequent experience. *Frequent* succession of like to like, bears an analogy to the *invariable,* and

upon this analogy we found an inference of causation; the point of analogy is between the *frequent* and the *invariable*, consequently the analogy must be established or presumed upon, in proportion to our experience of the frequency of the succession of like consequences to like antecedents. These grounds of the inference of a cause as is just stated are imperfect, and must admit frequent error, for we cannot define what number of successions of like consequences to like antecedents, are an adequate number to prove causation.

§ 11. Hence then, although we infer causation from succession, we are obliged to confess that we can do this only in certain cases; before we can admit the truth of an inference of causation, we must have had an experience of a sufficient frequency of a like succession. Different men will hold different opinions with regard to what constitutes a *sufficient frequency*, and the want of a possible definition in this matter admits a great diversity of opinion upon important points, and gives room for the distinction of close, and loose reasoners.

§ 12. But when once we have had experience of what is considered a sufficient frequency of like succession, we then infer some difference (where it is not perceptible) in cases in which the same consequences do not succeed the same antecedents. In such instances, we balance an account between like, and dissimilar succession; and we *assign a cause* only, where the *frequency* of the same succession (approaching to the *invariable*) exceeds that of the exceptions. Thus (not to quit our subject), if the exhibition of a particular medicine should be followed by recovery from phthisis pulmonalis in one instance, this succession would, where men are disposed to catch at straws, indicate a possible causation; if the same event succeeded to its exhibition in ten instances, its credit would be better supported; if in a hundred, better still. If it should succeed in five and fail in five, we should hesitate perhaps to assign it as the cause of recovery in the first five; if afterwards it should fail in fifty cases, we should say that in the five in which it was *followed* by recovery the cure was owing to *other causes*. If it should succeed in a hundred and fail in fifty, we should then perhaps judge the hundred to amount to an adequate number to establish the relation of the medicine, as a *cause* of recovery; while we should explain its failure in the other fifty, by supposing some diversity of circumstances, by which its relation as a cause was modified, to have prevailed. The conclusion amounts to this: we infer that a secondary is produced by a primary disease, upon an experience of a frequent succession of the one to the other, provided at the same time that our experience furnishes us with no stronger analogies to sensible causation, by which we are rather justified in considering them distinct.

CHAP. V.—*General Nature of Related Disease.*

§ 1. THE production of a secondary by a primary disease is accomplished by one or both of those modes of causation which we have assigned to be universal, viz. by addition or abstraction of constituents. The part which becomes the seat of the secondary disease is now identified by its causes as a state of health. This state is changed when the secondary disease happens—*changed* by what? by something added or something taken away; as, however the condition of disease always respects either exclusively or principally the properties which have been called spiritual, we are precluded an analysis of related disease, conducted with a view to be informed of precise states and *efficient causes.*

§ 2. In those cases of related disease which happen between seats which are connected by function, we are sometimes able to say, as in the case of paralysis, happening from injury of the brain, the secondary disease is here produced by *privation* of accustomed properties, &c.; in a case of convulsions, we should perhaps be inclined to say, in consequence of disturbance or injury of the brain, properties are *communicated* to the muscles which produce such and such phenomena; this, however, would be only an assumption, though perhaps it might appear upon further inquiry to be a probable one. But, in a general way, no advantage can result from an attempt at investigating according to this division, because, although it is the only one by which we can seek for sensible evidence, it is not adapted to subjects where our best information must be inferential, and that too founded upon analogies both numerous and obscure.

§ 3. Conditions of seats may be related either directly, as by the properties of life occupying the seats, or indirectly, as by relation of the properties of life of a seat with the preparation or distribution of the fluid material, which again is related with other seats. Sufficient has already been said by way of indicating that complexity which must be unravelled by him who is ambitious of giving a complete analysis of any one case which might be chosen as a specific subject. Without here attempting any further an analysis which belongs to particular inquiry, I shall consider related disease after a looser fashion.

§ 4. When a secondary succeeds to a primary disease, if they are to be considered according to the rules laid down, as holding a causative relation with each other; in every instance of related disease one of the following results ensues: 1st, either the primary disease ceases upon the occurrence of the secondary; or, 2nd, the primary disease preserves or changes its character, according to the relations of the properties of the secondary, with those of the primary seat; or, 3rd, one of the preceding results on the primary disease happens either by a relation with more than one secondary seat, or by an extension from a secondary seat by which, perhaps through many mediate relations, the primary seat may come to be affected, according to one of the above results, by processes to which it gave origin; or, 4th, the primary disease may produce a secondary, and the affection may from thence be further extended, and the disease in each seat might run the same course as if only one seat were the subject of it. This elaborate division admits of being reduced to two classes of related disease, viz. 1. those secondary diseases which tend to cure the primary; and, 2. those which do not tend to such a result, but on the contrary add only to the complexity of the symptoms, and perhaps ultimately convert disease into death.

§ 5. That certain diseases are related with each other in the way of cause and effect, is a remark which is cotemporary with the earliest records of medical observation. It is also a piece of information, *popular* with all classes, that the cure of one disease, whether spontaneous or by art, is sometimes followed by the occurrence of another. Thus, it is *common* to expect a favourable change of some internal disease, upon the occurrence of a cutaneous eruption; thus, also, it has fallen under the observation of the ignorant and unprofessional, that a cutaneous disease cured by external applications often produces visceral disease. The language of the vulgar in the first of these cases is, that the internal disease is coming out; in the second, that the disease of the skin is *thrown in*, or settled upon the lungs, for instance. To all physicians the class of facts here adverted to is well known; they have been made the subject of express treatises, and have been remarked upon in every age, and explained according to the prevailing pathology of the times. But the professors of medicine have of late been rather sceptical with respect to the assigned agency of the phenomena in question, though it is not improbable that their exception was taken rather against the doctrine of humours, &c. by which the phenomena were explained, than against the more modest inferences which they might be allowed to furnish. To all physicians of the present day the class of facts, designated as those of related disease, is well known: by some, these facts are not suffered to furnish an inference of a relation, that is, they are considered independent of each other; others admit the relation, and explain it in the language of the vulgar; others say that one disease, instead of falling or being thrown upon another part, is *converted* into a disease of another part: some

physicians admitting the class of facts, and admitting also the inference of a relation, believe that the examples are very rare; others are inclined to think them *universal*, aye, and to allow them only one tendency, although they might tend to 50, or 500 different effects. It will appear from this account that the existence of related disease has been long known, that the knowledge of it has become popular, and consequently there is no novelty in the statement of the fact. If we would improve our knowledge with respect to such disease, it must be, not by ignorantly generalizing a single limited class, but by a just analysis of its laws, by an inquiry into its nature, its frequency, and by an accurate discrimination of its instances. The first subdivision which we have proposed of this class is that of related secondary disease, tending to cure the primary.

§ 6. Perhaps the most unequivocal examples of related secondary disease, tending to cure that which occurs in a primary seat, are those of metastasis. A person might have pneumonia clearly characterized by its symptoms: the symptoms of this local disease on a sudden shall cease, and the subject become immediately affected with phrenitis, which shall be followed by death within eight and forty hours. These occurrences may be confirmed after death by dissection (quod vidimus testamur). If we inquire into the causation in this example, there are those to whom the whole process is perfectly clear, who will reply, the inflammation left the lungs and went to the brain; was it then the *same inflammation*, and if so, what was the object of its journey, or why did the inflammation take it into its head to travel? To analyze a little more curiously:

§ 7. Inflammation exists in the lungs: why does it cease in the lungs? either from that progressive causation (which has been described) taking place in the lungs, or from a progressive causation, taking place elsewhere, by which a relation is opened between the seat of such progressive change and the properties engaged in the disease of the lungs, the end of which relation is, that disease is established in a secondary, and ceases in the primary seat.

§ 8. The evidence in this case derived from the order of succession is, that the disease in the lungs being the antecedent, is also the cause of the disease in the brain which succeeds to it; in other words, the properties constituting inflammation of the lungs leave this seat and are transferred to the brain. But if the pneumonia is the antecedent to the phrenitis, what is the antecedent to the metastasis? or why does a disease leave a seat in which it is established? The alternatives which must form the answer to this question are suggested above: either a change takes place in the properties of the lungs, by which they no longer admit the state of inflammation, which is then assumed by some other viscus, already in a predisposed state to take up inflammation upon the cessation of it in another seat; or else the brain (continuing our example) assumes a state which is so related with the properties engaged in the inflammation of the lungs, as to produce a cessation of the inflammatory condition

in this seat. From this view it is obvious that the sensible succession is inadequate to determine the causation; for the brain may be the the first to assume a change, by which it cures the disease in the lungs; or the disease may cease in the lungs, from causation proceeding in this seat, and be assumed by the brain, or any other seat which is predisposed to this result, under the relations which obtain upon the cessation of a disease in a seat which it had hitherto occupied.

§ 9. The alternatives here suggested must obtain in every case in which the primary ceases upon the occurrence of the secondary disease, but they do not necessarily obtain in all cases of related disease: thus we say dentition disorders the bowels; this is a case of simple succession, which, by analogies before explained, we infer to be also one of causation. If, upon the occurrence of disorder of the bowels, the process of dentition were suspended, we should then have to determine whether the change preparatory to the metastasis took place in the bowels or in the maxillary nerves. The progress of consumption might be suspended upon the occurrence of pregnancy: here consumption, as a related state, preceded pregnancy, yet we know, as the cause in this instance is palpable, that the seat of that change which produced the metastasis was the uterus, or secondary related seat. Thus also the catamenia may be checked by an exposure to cold which will produce rheumatism; the change preparatory to, or causative of the metastasis is here also in the secondary seat. From these and many similar examples, we may perhaps conclude very generally, that the primary disease in metastasis does not produce the secondary, but that the metastasis itself is determined by a change which takes place in the secondary seat. Yet this conclusion must not be universal, for we know that the change which is preparatory to the metastasis may take place in the primary as well as in the secondary seat, as when inflammation of the brain succeeds the cure of erysipelatous inflammation of the arm or face, by means of cold lotions: this also I have seen in a fatal example. We must rest then with the alternatives which will respectively be adopted in the several instances, according to sensible evidence where this can be had, and according to the nearest analogies from defect of better proofs. Without, then, comparing instances which cannot be done accurately, so as to deduce a general rule of probability, with respect to the origin of the processes of metastasis, we will simply state the facts by a designation which will agree with either of the above alternatives of the mode of causation.

§ 10. Related disease, according to our reduced division, is of two kinds: 1st, as when a primary disease ceases upon the occurrence of a secondary; and, 2nd, as when a secondary merely succeeds to a primary disease. The former instances have been expressed by the word metastasis, which implies that the disease leaves one seat and goes to another: this, however, is a conjecture without proof, for an *inflammation* of the eye may be cured by a spontaneous diarrhœa; if the identical properties of the primary disease

went to the seat of the secondary, these properties, being those of inflammation, should produce inflammation of the bowels rather than a diarrhœa, which rarely occurs in inflammation of the bowels. If the identical disease of a primary is in metastasis transferred to a secondary seat, as *the character of the secondary is commonly very different from that of the primary disease,* it is necessary to infer that the identical nature of the primary disease is liable to be modified by peculiarities which belong to the secondary seat. Laying aside the word metastasis, by some it is said that one disease is *converted* into another. This term "conversion" is one which either does not carry a clear meaning, or if a certain meaning shall be agreed upon, it implies a theory which will require proofs. Either the word "conversion" implies the operation of a cause which produces its own *similitude,* as one man is converted to the *same opinion* as another; or as life converts constituents of food and air into life, &c.; or else it is employed with greater latitude, as water is converted into ice, &c. or as wine is converted into vinegar; if employed in the former sense, it is not applicable in the present subject, for we cannot suppose that the properties constituting inflammation are made those of a diarrhœa, or that they are converted into an effusion of blood, &c.: if the term is employed in the latter sense it designates no *one* species of causation, but may apply to any, as cold converts water into ice, that is, cold and water make ice; or sulphuric acid will *convert* magnesia into a neutral salt, that is, sulphuric acid and magnesia constitute a neutral salt. I would not be understood that the term is violently objectionable, or that something may not be said on both sides respecting its use in these cases, but its implication in the first definition will bear a cavil, and in the second it is no term of distinction.

§ 11. The first class of related disease, viz. that in which a primary ceases upon the occurrence of a secondary disease, may be called *substitution* of disease, which merely expresses the fact that one disease has taken place, while another has ceased; the word "vicarious," which is familiar in medicine, expresses the same thing. The second class of related disease, viz. that in which the primary does not cease upon the occurrence of the secondary, may be called related extension of disease (the causative relation being in both cases assumed upon the grounds before stated).

§ 12. The examples of substituted disease are very numerous, and it is upon this experience of their frequency that the relation of cause and effect in some or other of its modes comes to be inferred to subsist very generally between them. We cannot, however, upon this point compel belief.

§ 13. Although the examples of substituted disease are very numerous, they are not sufficiently regular to admit a classification of those primary diseases which are likely to be cured (to beg an expression) by the occurrence of secondary ones. We can rarely, (owing to this irregularity) perhaps we can in no case *anticipate* the cure of a primary disease by a secondary one; that is, we cannot

pronounce that a certain secondary disease will succeed to the primary, and that the latter will then cease. We more frequently expect the *cessation* of a primary disease, when the symptoms of a secondary one, of the tendency of which we have had experience, do actually appear, than we anticipate a substitution of disease, while the existing symptoms occupy exclusively the primary seat. There is, however, an exception to this remark, when the same secondary has been substituted for the same primary disease, in one or more instances.

§ 14. It is desirable on this subject that the collective experience of individuals should be possessed, in order that our reasonings may receive the advantage which must be derived from a correct estimate of the frequency and peculiarities of substituted disease. My own experience of these diseases is pretty extensive, and I have elsewhere made some progress in an attempt at their classification; at least, I have collected and arranged many detailed cases. In this place a few only of the instances can be adverted to, as illustrative of the cessation of one disease by the substitution of another. In this way,

1. Chronic pain in the head may cease upon the occurrence of a chronic diarhœa.

2. Violent pain in the head, accompanied for a considerable time by general derangement of the health, and particularly of the nervous system, may be cured, to use a common term, by the formation of an abscess in the back.

3. Pain in the head, disorder of the nervous system, which has proceeded to insanity of three weeks' duration, may all cease upon the formation of a carbuncle in the back.

4. Chronic plethora of the vessels of the head, producing vertigo, lethargy, &c. requiring frequent depletion by cupping or by the lancet, may cease, so as never again to require these artificial measures, upon the occurrence of a large incurable ulcer in the back.

5. Insanity, which had existed a twelvemonth, ceases perhaps under an enormous accumulation of fat. The formation of fat is of all others the most frequent instance of substituted disease. It cures habitual disorder, improves the condition of that which is called a delicate constitution when it occurs. The formation of fat tends to maintain health by *defining a harmless seat of disease* while it lasts, and it is seldom spontaneously removed without the occurrence of a substituted disease in some less convenient seat.

6. Vertigo, alternating with asthma, may cease upon the formation of an abscess of the foot; this abscess may produce a troublesome wound, upon the healing of which apoplexy may take place, followed by paraplegia and fatuity; to this may succeed swelling of the legs with improved motion, and recovery of the intellectual powers; to a cessation of the swelling of the legs may succeed spasmodic breathing, which ceases again upon the return of the swelling of the legs; this again ceasing, apoplexy and death supervene.

7. Apoplexy followed by delirium, continuing for a fortnight, might cease upon the occurrence of a cutaneous eruption.

8. Tic douloureux of the sciatic nerve may succeed to the cure of a prodigious cutaneous eruption by external applications; this disease in the nerve might be intense for a time, and cease upon a return of the disease of the skin; it may return when the disease of the skin has again ceased, and be again suspended by pregnancy, and the offices of suckling, &c.

9. Convulsions, repeated at short intervals for a week, in a child may cease entirely upon the occurrence of a considerable œdematous swelling of one arm.

10. A violent pain in the stomach, occurring in the form of two paroxysms a day for many years, each paroxysm ending spontaneously by vomiting, may be suspended during seven months of pregnancy, and return a fortnight after premature labour at this period.

11. Excessive sensibility of the retina, producing violent pain under an exposure even to a moderate light, may continue for years and bid defiance to remedies, and finally cease under a spontaneous chronic diarrhœa.

12. Sense of fluctuations and noises, as of waterfalls, in the head, sometimes attended with irregular fits of insanity, may cease upon the occurrence of temporary diabetes, or a most profuse secretion of urine, continuing not more than two or three days. The same disorder of the head may continue for months in the same subject, and cease in the same manner in two or three distinct attacks.

13. A catarrhal disease of the bronchiæ, attended with an expectoration of perhaps a pint and a half of mucus in twenty-four hours, may succeed to the cure of an extensive and inveterate cutaneous disease of the back.

14. Vertigo and pain in the head may alternate for days, with a spitting of blood from the lungs for weeks or months. The spitting of blood having ceased, the subject may become mad, and finally die of apoplexy.

15. The instances of vicarious disease from the suppression of the catamenia form a numerous and well-known class, to the familiar examples of which it is unnecessary to add.

16. Vertigo might cease upon the occurrence of hydro-thorax; this latter disease may cease under an enormous swelling of the legs, and this latter terminate in a prodigious secretion of urine. This order may be observed in three attacks, and the subject finally die of apoplexy.

17. Fever with delirium and a pulse of 140 may continue for six days, and the patient *effectually resisting* the administration of *a single medicine*, may from that time have had no evacuation from the bowels; at this time a diarrhœa occurs, the patient may have fourteen or fifteen stools in as many hours, the fever may immediately abate, the tongue become clean, the delirium cease, and the patient may be in every respect convalescent in two days after the occurrence of the diarrhœa.

18. The substitutions of seats in gout are too numerous and well-known to require a single illustration.

These cases here so rapidly sketched have fallen under my own observation. I could swell the list to five times, or may be ten times this number: these however must suffice where my business is rather to indicate generally, than to enter into particular details and inquiries.

§ 15. It has been remarked that there is nothing new in the observation of this class of diseases, Hippocrates was as well aware of them as any of those who have succeeded him. But there would be something new in the inference that all diseases which succeed each other in the different seats hold, like the substituted ones indicated above, a curative relation: this inference would indeed be new, and it would be no great difficulty to prove it *false*. We will keep this refutation a little in view, in our exhibition of a few examples of our second class of "extension of disease."

1. A schirrous tumour of the breast, of a small size, proceeds on to the ulcerated stage of cancer; the axillary glands which are in the course of the absorbents, proceeding from the seat of the primary disease, become swelled, indurated, and finally, perhaps, the skin covering them ulcerates or sloughs, and the secondary disease resembles in its phenomena the primary one. The primary disease in the mean time runs its course, sloughing and ulcerating and bleeding, &c. until the patient dies. The only result of the secondary disease in this case is, that the patient has a cancerous disease in two seats instead of one. During these processes the constitution also participates in the local disease; to mention only one consequence, a febrile diathesis is produced. It would be difficult to shew how cancer of the axillary glands is likely to cure cancer of the breast, or what tendency fever has to arrest the progress of an irritable ulcer of such a kind, when we know that all its symptoms are aggravated by any causes which produce fever or quicken the circulation. This is one instance of extended disease.

2. A chancre on the prepuce, left to spontaneous processes, continues to ulcerate; from this primary arises the secondary disease of an abscess in the groin: we should not in this case expect the primary to be much benefited by the secondary disease; we know that the chancre spreads and the bubo will spread; that from these seats the disease will be extended to the skin, to the throat, and to the bones. From all this extension of disease the primary one, the chancre, does not derive the least benefit; all the consequences of it tend to death, and before this event happens the primary disease, which, according to some reasoners, should have been cured by the consecutive processes, has unluckily destroyed without a vestige the whole organ in which it was situated, together perhaps with some collateral ones belonging to the same system. If, again, the *tendency* of the consecutive phenomena should be inquired after, we have only to observe, in regard to the primary disease, that the local destruction of parts goes on the more rapidly, in propor-

tion as the constitution suffers, and the seats of the disease become extended.

3. Strictures in the urethra produce hernia humoralis. This is another instance of complication of disease without curative results.

4. Disease of the liver obstructing the return of blood from the veins which unite in the ven. port. produces ascites. Unless dropsy of the belly may be supposed to benefit an enlarged and indurated liver, by affording it the advantages of a warm bath, it would be difficult to say in what other way the secondary tends to cure the primary disease in this instance.

5. Ulcers of the legs are produced by a varicose state of the veins. The secondary disease in this case has never been suspected as the spontaneous cure of the primary one.

6. The irritation of a tubercle in the lungs produces fever; fever accelerates the suppuration of the tubercle; fever maintains ulceration in the primary seat; ulceration tends to perpetuate fever; these processes in regard to each other are *not remedial*, on the contrary, each disease is increased by the other, and both concur to produce death.

7. Water in the brain may produce paralysis of the optic nerve. It would be difficult to shew the tendency of blindness to cure hydrocephalus; the water increasing, the pressure of the fluid impairs respiration, and finally causes it to cease; an extension of disease which stops a person's breath is not the likeliest method of prolonging life, which it must be presumed is the end of every agency which *may be termed curative*.

8. A wound of the foot may produce tetanus: it has never been found that the state of tetanus was particularly conducive to the healing of a wound. These instances, as well as those of our first class, may be greatly multiplied; but we rather want to make correct inferences from these examples than add to their number.

§ 16. Our conclusion from these facts brings us back to the division which was prefixed to them, viz. of related diseases; some exemplify a substitution, and others a mere extension of them: in the former, the secondary is curative of the primary; in the latter, the phenomena of disease are multiplied, and in every seat they run their own course, sometimes with an obvious aggravation of the primary by the re-action of the secondary disease, but more commonly with no other communication or influence than that which is inferred of the secondary in regard to the primary disease, from analogy with sensible causation.

§ 17. But, it may be inquired, although in these cases of extended disease the secondary does never cure the primary, may not the *tendency* of it be to cure? would it not cure the primary, provided it did not *kill* in the attempt; or, by being extended to the *wrong seat?* There is absurdity in these questions, although there are not wanting those who would be so simple as to ask them. The questions amount to this: if a wound which produces tetanus, instead of affecting the nervous and muscular systems in this manner, were

to produce a gentle diarrhœa, would not then the state of the wound be probably benefited by such a consequence? The question is best answered by observing, that if no other relations were exhibited but such as are curative, we should then have curative relations in disease, and no others. If a disease of one seat cannot get well unless it is cured by disease of another, how happens it that the state of disease ever ceases at all? A first disease, it is said, requires a second to cure it; and what cures the second? a third, it must be replied; and so on *in infinitum*. It is obvious that some organ must have the power of returning to health without being restored to this state by additional disease; and there is no reason why the secondary seat should be more lucky in this respect than the primary seat of disease. The same sagacious reasoners observing that one disease is sometimes preventive of another, as a diarrhœa of a disorder of the head, or a cutaneous eruption of a disease of the lungs, have wisely concluded that *disease* is salutary: to this magnanimous inference it may be modestly replied, that though it is better to have a little disease than a great one, yet it may be doubted whether it is not better to enjoy the state of uninterrupted health without any disease at all. The most that can be said of diseases, which, as they exist, are merely extended, is, that from their analogy to the substituted diseases, they may sometimes be expected to operate favourably upon the state of primary disease by progressive causation; that one would not always check a secondary disease in a safe seat, upon the ground that secondary is sometimes remedial of primary disease.

§ 18. There are others who would attribute all diseases to some particular accompaniment of disease: thus, fever, say they, is produced by an accelerated action of the heart; and what accelerates the action of the heart? a previous change of the principle which governs its motions; a change, the general history of which it has been attempted to describe. Another disorder is said to be produced by a *determination of blood*, as to the head or lungs; and why does a particular determination of blood take place to any seat? say it arises from an enlarged or disproportional calibre of its vessels; and why does this disproportionate calibre take place? either from defect or modification of a vital property which governs the calibre of vessels, or from a fault in their mechanical constitution: if the former, we understand no more than that vague notion that some change has taken place in the identity of the governing principle, which directly produces the effect or symptom in question; if the preternatural calibre arises from a fault in the mechanical constitution of vessels, this modification of a structure must be preceded by that peculiarity of the principle which forms it, to which, directly or indirectly, in some or other of its seats (as has been many times shewn), peculiarity, whether in the chymical or the mechanical department, is ultimately in every instance to be attributed.

§ 19. There are others who will talk about spasms: thus, say they, fever is produced by spasm of the extreme vessels. To say nothing about the bare assumption in this case, if spasm produces

fever, what produces the spasm? cold, say they: let heat be substituted for cold, and let the spasm be relaxed, as they allow it might, what still produces fever? the return of spasm: and what produces the return of spasm? not cold again, for the patient may be in a warm bed. This question they will attempt to evade by replying, a *disposition* to spasm; allow it: and what shall we say of this disposition? simply this, that it is some change which we do not understand; and why not say this at first?

§ 20. Another set will affirm, that all diseases are produced by increased or diminished excitement. To these I would suggest that we have no standard by which to measure the quantity of excitement. But if, par hazard, their ingenuity should discover one, it may then be asked what is meant by the term *excitement?* say it is the power of action which prevails in a living body. This power of action, say they, is either too great or too little; and to one of these varieties are to be attributed all the phenomena of disease. A power of *action* refers either to the voluntary or the involuntary muscular system: to take a specimen of the first, inflamed muscles (or the muscles in that state of a limb which succeeds to a violent injury, as a compound fracture, followed by the most intense inflammation) are not capable of performing voluntary motion, this is a diminished power of action; if the limb is paralyzed by ligature, or division of its nerves, the muscles are thus also rendered incapable of voluntary motion: this likewise is a diminished or lost power of action, yet it will hardly be said that the two states are the same; they have the same effect upon the limb, or they agree in being a privation of the power of motion, but the state of the moving powers has undergone a *change* in either case, which is not distinguished by a term expressive only of one particular, in which they agree; in the one case, motion is prevented by a modification or disease of its power, in the other case it is lost, by an intercepted communication with its source.

§ 21. In the second department, the power of motion in the heart may be such that the actions of this organ are at the rate of 120 in a minute: with this power of action of the sanguiferous system, there may be either consumption or cancer, or a gun-shot wound, or phlegmonous inflammation, or inflammation of the liver, &c.; or there may exist no other symptom of disease, save this increased action of the heart, as in some temporary states of nervous disorder. If the power of action is the cause of disease (the same action being produced by the same power), the same actions should produce the same diseases; if they do not, there is another cause of disease besides the power of action; the blood may be moved through a cancerous ulcer and an ulcer that is not cancerous with the same velocity; there may be an agreement of the pulse in both instances, yet the diseases are different. Oh! yes, say the supporters of this doctrine, there is a different *disposition* in the different diseases; and that this difference may be something besides a variety in the powers of motion may be guessed from the facts that fluids may be urged through all the vessels in the body by a common

power of motion, and yet with the same rate of actions: in one person a lumbar abscess shall form, in another a tubercle in the brain, in another an exostosis or a node of the tibia, in another a mortification of the toes, in another a gall-stone, in another the conversion of a kidney into fat, in another dropsy, in another calculus of the kidney, bladder, or prostrate gland, in another ossification of the aorta, in another rheumatism, in another necrosis, in another ulcer of the leg connected with varicose veins, &c. Then, say they, the *local powers of action* are not the same. Before this can be asserted, a test should be proposed by which we might estimate their difference, so far as they can be judged of by the pulse in the respective seats they are all the same, or they might in several examples be found the same; and if pus is formed and variously modified, and calculus is formed, and the textures in one instance preserve their integrity, and in another ulcerate, and in another mortify, and in another produce chalky depositions about joints, and in another throw out a preternatural growth of bone, and in another produce an enormous steatomatous tumour, in another a schirrous tumour endowed with all its predisponent properties, &c. it may be guessed that these instances shew the agency of properties which are not comprised in an increased or diminished power of action, seeing, also, and setting aside other proofs, that the power of motion estimated by the only test which can be proposed, may be in all these insstances the same.

§ 22. Others there are who fancy they explain diseases by calling them *associated motions, catenated movements, associated sensations*, &c. This jargon can scarcely be meant to designate a causation of disease, it is an attempt at a classification (or else it is an attempt at nothing) upon grounds so absurd as to be altogether below a comment. We may make motion and sensation a general test of the presence of disease, as there is no disease which does not either affect motion or produce sensation of some kind; but *different states* of disease may be connected with the *same movements* (as in the circulation, for example,) or with the *same sensations*. We form our opinion of the nature of disease frequently from the motions, or the sensations of its seat; but the circumstances of sensation and motion are only the symptoms which indicate particular states of disease upon analogy; that is, because such sensations have been found to accompany certain states of disease. The instances in which a single symptom can stand as the representative of a disease are very rare: perhaps there is no disease which may be defined without the enumeration of many symptoms; symptoms are the sensible results of invisible changes, and they become in turn the causes of disease, as in those examples in which certain symptoms produce the consequences of *related* disease, as a pulse of 140 may be produced by a compound fracture, and the brain in this case, unable to sustain this vehement circulation, exhibits under it the phenomena of phrenitis, as delirium, &c.

§ 23. There is one other doctrine, which, as it is adopted to some extent, appears to require a notice. The doctrine in effect is this,

no local disease would exist if the general health were good: there is no general disorder of health which does not originate in some of the abdominal viscera. This doctrine is at least very comprehensive and apparently very simple. We shall examine a little the grounds of it, or how far it is likely to be *true*. To reduce it to its greatest simplicity, all, or we will put in a saving clause and say most, diseases *originate* in disorder of the stomach and bowels, &c.

§ 24. The evidence by which it is attempted to support this doctrine is, 1st, there are few diseases in which the symptoms of disorder of these viscera, or of some of them, are not present; 2nd, these diseases get well as the symptoms of disorder of the preparatory organs disappear. To reduce the question as much as possible without forsaking the doctrine, instead of including all these viscera, we will speak of one merely as a representative of the rest, or of as many as may be disordered, and this one we will say is the *liver:* "all or most diseases *originate* from disorder of the liver."

§ 25. The liver is disordered in most diseases, therefore disorder of the liver is the cause of most diseases; this is the argument: we will suppose the disorder of the liver to be indicated by furred tongue, loss of appetite, irregular bowels, &c.; it is best to agree upon one sign, to avoid a multiplicity of words: let a furred tongue then be, if occasion requires it, the representative of all the other symptoms of disorder of the digestive organs.

§ 26. Disorder of the liver can be assigned as the cause which produces other disorder only upon the argument of succession, which is analogous to causation. There is disorder of the health accompanied by a furred tongue: can it be settled in all cases which of these is the antecedent, and which the consequence? can it be said whether the liver is disordered first and then the health, or whether other disorder precedes that of the liver? the succession is not clear; and if this fails the argument loses its principal, if not its only support. There are *other* cases in which the *succession* is clear: a person from exposure to the weather has a rigor, he feels a lassitude with dull aching sensation over the whole body, these are the *first* symptoms; the pulse is quickened, and the tongue becomes furred, and there is loss of appetite, such is the *sensible order* of occurrence. In this instance it is clear, from the obvious *succession* of symptoms (and we have nothing else to trust), that other disorder precedes that of the digestive organs. Take another case: a person receives a deep wound, a lacerated one, or a gun-shot wound; his tongue was clean enough before this happened, but in thirty-six hours from the infliction of the wound the tongue is furred and there is loss of appetite. From these facts, and there are many such, it is proved that disorder of the digestive organs may be *produced by disease originating elsewhere*, at least as truly as that disease elsewhere might be produced by disorder of the digestive organs. These facts refute the doctrine as an universal

one: if it is still asserted to be true, it can be so only in particular cases which remain to be discriminated. The argument now stands thus: there are cases in which the processes of disease in other seats palpably precede disorder of the digestive organs; but there are no cases yet cited in which disorder of the digestive organs obviously precedes all other disease, for in general a furred tongue is only the accompaniment of other disease, and it would be difficult, perhaps in most cases impossible, to establish a priority of occurrence.

§ 27. But other diseases get well, it is said, as the symptoms of disorder of the digestive organs disappear. This would very naturally happen if disorder of the digestive organs were maintained by a disorder elsewhere, which, subsiding, admits the recovery of the digestive organs; as the irritation of a gun-shot wound having abated, the appetite returns and the tongue becomes clean. The priority of the symptoms alluded to cannot in most cases be discriminated; hence, in most cases we are not warranted in assigning disorder of the digestive organs as the cause of disorder elsewhere, with which it might be connected, while the contrary, or that other disease precedes that of the digestive organs, is obvious in some other instances.

§ 28. Granting then the assumption which, to favour the doctrine in question as much as possible, was supposed to be conceded, we find that the evidence cited to prove the dependence of disease in general upon the state of the digestive organs is altogether inadequate; it fails of supporting the doctrine, even if the assumptions it involves are freely granted. To assert that disease can take place only as a consequence of disorder of the digestive organs, amounts to saying that disease can *originate only in one seat*, or that there can be only one seat of primary disease; or, to return to our reduced illustration, no disease can take place without disorder of the liver.

§ 29. If, then, disease cannot take place without disorder of the liver, how happens it that the liver itself becomes diseased? The very occurrence of disease of the liver proves that disease might happen without being preceded by disease of the liver; and if it might originate in this seat without being produced by disease, as it must, when from a healthy a disordered state of the liver takes place, why may not disease in other seats have *an equally independent origin?*

§ 30. But granting, still further, all sorts of postulata, can it in *any case* be proved that disease *originates* in the liver? Take for example a tubercle *of the liver;* why is a tubercle formed in the liver? from a predisposition, it must be answered, which exists in the liver; and what is the history of this predisposition of properties of the liver to form a tubercle? the predisposition, it must be replied, takes place in the series of that progressive change which has been described; and did the first processes of this progressive change take place in the liver, or in a related seat? we have reason

to think that the liver obtains properties of the regular dependent kind, perhaps from a nervous centre; at all events, we cannot prove that the first processes of the predisposition to a tubercle originated in the liver, unless we can first prove that its life is independent of all other seats, and that the properties determining the earliest processes of progressive change have been allied to the assimilating life of the liver from its first development in the uterus.

§ 31. But not to encumber a plain argument with subtleties, the preceding exposition of the force of the evidence is sufficient to shew that such a doctrine cannot be rationally entertained; further, that it must be positively rejected. There is, however, one other argument, cited perhaps in favour of the doctrine, upon which also we might bestow a short notice: this argument is deduced from the operation of remedies, and, fairly stated, is as follows: the diseases which are affirmed to be dependent upon the digestive organs get well (sometimes) under the operation of remedies which are designed to correct their disorder; which fact, it may be continued, must be allowed to be a proof of their dependence, &c. The question is, not what these remedies are *designed* to do, but what they actually do; and as for what this argument must *be allowed*, we shall examine a little further before we allow it any thing.

§ 32. Suppose a disease of the skin to be cured by blue pill; suppose that the alvine excretions become regular and good; suppose that the secretion of bile is improved, that the appetite returns, that the tongue becomes clean, and that the disease of the skin gets better, and finally well, under the use of the blue pill; does it therefore follow that the disease of the skin was produced by any of, or all these circumstances belonging to the abdominal viscera? the operation of the blue pill may be upon a seat which is only related with the liver, bowels, &c. as well as directly upon these viscera; or the disease of the skin may be cured, as by a remedy which is applied to its seat through the medium of the circulation; there may be no dependence at all between these phenomena, but they may all cease, as accompaniments only, under the operation of an agent whose properties are remedial in regard to them all; or, granting further all that is required, viz. that the blue pill acts exclusively upon the liver, stomach, bowels, &c. and that the disease in the skin gets well under the mercurial excitement produced in these parts, yet it does not follow that the disease of the skin *was produced by their disorder*, for the preternatural affection produced by the mercury may have a curative relation with the disease of the skin; the mercury may operate upon a common principle of change, the preternatural affection of the abdominal viscera may cure the disease in the skin in the same manner as mustard plasters on the soles of the feet may cure gout in the head, or as a blister on the side may cure a pleurisy. Yet in these cases, which are the most level to our experience, we do not set up a causative relation: no one will employ this, which

is a parallel argument, viz. gout in the head is produced by disorder of the feet, or pleurisy is produced by a state of the skin covering the side, because agents applied to these parts will cure diseases occupying other seats. Nothing can prove causation between diseases where the succession is not clear; and even where the succession is clear, this must be admitted as a proof only, with the restrictions before mentioned.

§ 33. But, it will be further insisted, in those diseases which blue pill cures, the stools are black, the secretions depraved, &c. This fact, singly, proves only associated, or concomitant disease in different seats. If upon a spontaneous evacuation of similar matter from the bowels connected disease should cease, according to the only rules of reasoning which can be defined, we are then to infer an example of that class of related disease which is by substitution; that is, the disease elsewhere is cured, according to such evidence from symptoms, by disease of the abdominal viscera.

§ 34. That disease of the stomach, liver, &c. may, as well as any other parts, become the seats of related disease, whether of substitution or of extension, cannot be denied. Indeed, in our sketch of an illustration of related disease, this degree of importance has been assigned to these viscera: thus, an excessive irritability of the retina which existed for years, while the health was in every other respect good, has been cured by a spontaneous chronic diarrhœa; and of the class of simple extension, thus, a local disease, say in order to avoid a cavil an artificial one, as a gun-shot wound, with diseased bone, may impair the appetite and totally disorder the functions of the abdominal viscera: this disorder began perhaps in the leg; it may be extended to the brain and nervous system; or it may be extended from this system to that of the preparatory organs, and, from disorder of these organs in an adequate degree, the disorder may be extended more or less to the whole system. This is the greatest share which can be allowed to these organs in the complexity of disease: they may become the seats of related disease, this may be disease either of substitution or of extension, and these organs may, in common with other parts, become the seats either of primary or of secondary disease. But, as the seat of an *universal origin of disease*, the notion can be supported only by arguments which will scarcely bear the slighest examination, and which may with the greatest ease be refuted, even though arguments of a similar description should be multiplied a hundred fold.

§ 35. The discussion here pursued with respect to the nature of related disease, may be nearly comprised in a summary of the following kind:

1. By related disease is implied conditions of the properties of a seat which produce effects, either curative or not, in the way of causation.

2. Causation between phenomena in animal bodies is inferred from succession in a sufficient number of instances, either of the

same phenomena or of different phenomena, which so far resemble others, of which we have had a satisfactory experience, as to admit an enumeration under the same class. This evidence is founded on analogy to the synthetical test of causation: if we require it to be confirmed, we must employ also the analytical test, as before explained.

3. Disease may be related either in its own or in another seat. The first, as inflammation of a part, is related with suppuration, or as schirrus is related with cancer; the second, as a disease of a nerve, may produce disorder of the brain, and convulsions over the whole body.

4. Related disease in the same seat is a progressive causation among the properties which belong to the seat, in the course of which different phenomena are exhibited, according to the relations subsisting between properties.

5. If a primary produces a secondary disease, the seat of the secondary either receives properties from that of the primary disease, or properties are withheld or abstracted from the seat of the secondary by the state of the primary disease.

6. We suppose that the properties producing disease are *communicated,* when a secondary happens as a consequence of primary disease, the seats of which have no natural relation of the *dependent kind* in the condition of health: the phenomena of irritation and sympathy may be supposed of this kind, as dentition affecting the brain mediately or directly, and producing fits; biliary calculus producing vomiting; inflammation of the liver producing pain of the shoulder, &c.

7. We conclude that disease is produced by *privation* of properties in the secondary seat, when the healthy state of this seat is dependent for natural communicated properties upon the seat of the primary disease, and when the function which is dependent upon such communication is lost: thus disease of the brain may paralyze the retina, or produce the same effect in this secondary seat as a ligature upon the optic nerve.

8. But disease of a primary may produce disease of a secondary seat, where a relation subsists of the regular dependent kind by *communication* of properties, as when the relation is disordered, as perhaps irritation of the brain producing convulsions of the muscles.

9. It is also possible, according to our causation, that secondary might be produced by primary disease, by *privation* of properties where no natural dependent relation subsists between the seats; as if a *preternatural relation* were opened, the effect of which is to render the secondary seat a source of properties to the primary one; thus leaving the state of the secondary seat to be identified by *remaining properties,* which are deficient in those which would constitute its healthy condition. The discrimination of the mode of causation in these instances must always be difficult, and the conclusion very dubious; such, however, are the alternatives.

10. If a primary ceases upon the occurrence of a secondary disease, it ceases, either because the primary disease has left its seat, and produces the secondary, or because the secondary, being established by causes either wholly or in part independent of those engaged in the primary disease, is so related with, as to cure the primary disease. The first of these happens from progressive change, in the seat either of the primary or secondary disease; the second, either from communication of properties from the secondary independent state of disease to the primary one, or from privation of the properties of the primary, in agreement with a new relation opened between it and the properties engaged in the new state of secondary disease. The causation also in these cases must be dubious: such again are the alternatives. If this subject were not already sufficiently complex, it may be suggested that, in an analysis of these processes of disease, we have also to define the share in them which might belong respectively to the properties of life, to the mechanical state of the structures, and the chymical conditions of the fluids. These latter are to be considered as re-agents.

11. In attempting to discriminate the mode of causation in related diseases, we can only scrutinize the succession, which will rarely afford much light, because the processes of disease in related seats, although in the beginning there might be an obvious antecedent, will in their course appear synchronous, or so mixed that a precise order cannot be distinguished. Such, however, are the indications for minute inquiry; and, to obviate a reliance upon the false theories which would explain these phenomena, it has been proposed merely to state the facts, that, of related diseases some are substituted, or curative, and others are a mere extension of disease to related seats. It appears from the facts, that disease in some, or many seats, may be cured by an agency which is extended from a related seat; and this agrees with the design of employing remedies which operate not upon the seat of the disease, but upon some other. This agreement, and the foundation of the design, we shall presently have occasion to examine.

CHAP. VI.—*Therapeutics.*

§ 1. IN speaking of the general nature of disease, it has been observed, that our means of analysis do not enable us to define in what its variation from the state of health consists: we cannot say what properties are foreign, what deficient; what combinations have taken place, what combinations it is necessary to separate, what combinations it is necessary to restore, or what new ones to produce, &c.; we do not know in what disease consists. Yet, with this profound ignorance, we boldly employ agents of various powers; and he who understands in the common way the adaptation of these agents to certain cases, will sometimes succeed in restoring health where death would have been the spontaneous event; and will very frequently restore health in a short time, in those cases in which nature would perhaps have accomplished the same end by a series of lingering and protracted operations. The modus operandi of medicines is what I now propose to consider briefly.

§ 2. By the exhibition of medicines it is intended to change the existing or diseased, and to restore the former or healthy identity of the properties constituting an animal body; whether these changes respect the system generally, or some individual part or parts of it. The exhibition of medicines being an introduction of foreign properties, if the cure proceeded on a *direct principle* of causation, it must be pre-supposed that disease consists in a deficiency of properties, and that those of the medicines are the identical properties, the privation of which produces disease.

§ 3. There would be absurdity in attempting to establish this as a general principle of cure: and yet there are some cases in which it would be difficult to prove that this was not the mode of cure. We must, however, take a general view of the facts which relate to the question, if we would attempt the discovery of a general principle. Mercury cures syphilis: is there any reason to think that the disease which we call syphilis consists of a deficiency of mercury, local or constitutional? Sulphur cures the itch: yet we can scarcely presume that the itch arises from defect of sulphur; or that fever arises from defect of antimony, because it might be cured by James's powder; or that fever consists in

the absence of calomel, because this also might cure fever; or that pleurisy consists in a deficiency of nitre, or in the want of a blister on the skin; or, pursuing the direct principle of causation, that pneumonia happens from excess of blood, because it may be cured by repeated bleedings: we cannot attribute the disease to such a cause, seeing that the pneumonia might happen the day after a pint of blood has been taken from the arm, at which time there is a pint of blood less in the body than existed in it a week before, when pneumonia was not present; or that apoplexy is produced by excess of blood, seeing that fatal apoplexy may take place in a subject who has been bled twice a week for a month previously, and lived upon gruel; there must certainly be less blood in the body at the end of such a month than there was two months before, when the subject was in good health and in habits of full repletion. If it be said these diseases are produced by a local excess of blood, I ask what occasions such local excess? it must be answered, previous disease: such illustration may be greatly extended. To this may be added examples of the following kind: a person having a pain in the head with a furred tongue, may become free from the pain in the head and the tongue might become clean, after losing twelve ounces of blood from the back of the neck by cupping, without the use of any other efficient remedy: the same result, in a case of a similar character, may be produced by emetics; the same by bleeding from the arm, or from the temples by leeches, or by digitilis; the same from aloes, antimony, blue pill; by an issue; or a blister on the scalp; by change of air; perhaps by laudanum, &c. The inference from these facts (and there are hundreds of such) is, that the same results might be accomplished by different means. If the state of disease is changed and the condition of health restored by agents which supply precisely those properties which are deficient, or remove those precise ones which are in excess, how happens it that the agents producing this similitude of effects are so greatly diversified?

§ 4. The question, *how* many different agents produce the same effect? may be answered thus, by one determined to support the doctrine of the direct causation: "All these various remedies may have some precise properties in common, with which alone the state of disease is related; these properties being allied with different substances, may appear to form a multiplicity of means of accomplishing one purpose, while in reality the *efficient properties* are alike and common to them all." This observation is perfectly just, and unanswerable in some other cases of causation: thus, a bullet may be propelled from a tube either by the force of air or of gunpowder, or perhaps steam; these three are different, but act by a common property, viz. a force of expansion with which the effect is related. Thus, also, ipecacuanha, antimony, zinc, &c. are capable of exciting the action of vomiting, which would not take place unless these substances contained a common property which identified the state necessary to vomiting; thus, also, the

skin may be destroyed by boiling water, by a hot iron, by the flame of a candle, by melted lead, by a heated coal, by boiling oil, &c.; these appear different causes, that is, the *efficient* cause, viz. heat, is differently allied.

§ 5. But, in the cases of disease, the analogy to these latter instances does not obtain: a disease consists either of defective or of foreign properties compared with the state of health; if it is only one of these, or both (and there is no alternative), the cure, or restoration of health, must require either that the deficient properties be supplied or the foreign ones removed, or both; here again there is in the efficient causation no other alternative. But the cure by remedies is accomplished in contradiction to these modes, and therefore these modes, which are the only ones of direct causation, cannot be the modes by which remedies act: thus, suppose our pain in the head to arise by defect of the tonic power of the arteries, by which a preternatural dilatation is admitted, emetic tartar and aloes will cure this defect of tonicity: if they do it by supplying the tonic power which was deficient, how happens it that leeches, or bleeding from the temporal artery, both of which *abstract* blood, and do not supply deficient properties, will also produce the same effect? or, suppose the pain in the head to be produced by some properties deficient and some foreign, a bleeding from the head can be supposed with the greatest latitude of assumption only to remove properties which are foreign to the state of health. Yet the disease ceases, leaving the supply of the deficient properties unaccounted for.

§ 6. It is sufficiently plain from these considerations (and indeed by a little further discussion, which seems superfluous, it might be demonstrated) that the general operation of remedies is not by supplying deficient, or removing foreign properties, in the direct or efficient mode of causation, as if disease of the bowels consisted in a deficiency of some properties which exist in rhubarb, &c. but that these properties produce their effects by an *indirect causation.*

§ 7. We find that this inference, deduced in conformity with our minuter reasonings, is equally supported by the palpable effects of remedies: so far from unchanging the diseased, and restoring the healthy state by the communication, or the removal of precise differential properties; so far from this, all the remedies which have a sensible operation are themselves, as is well known, the causes of disease, or all tend to produce preternatural conditions. This effect will be recognized by enumerating a few of the remedies chiefly relied on: such as mercury in its various forms, aloes, scammony, jalap, colocynth, elaterium, gamboge, neutral salts, senna, antimony, ipecacuanha, squill, digitalis, nitre, assafœtida, bleeding, blisters, warm bath, opium, brandy, wine, ammonia, æther, arsenic, hemlock, &c.; all these remedies which have sensible effects are not the direct causes of health, but of diseased states. If, then, an agent, whose direct operation is to produce

disease, has also the property of restoring health, we must seek after a mode of causation by which this latter effect is accomplished in an *indirect way*. The question, otherwise stated, is this, how do remedies, whose immediate effect is to disorder the seats of their operation, produce health?

§ 8. The answer to this question is, that they do it in general by mediate relations, or they do it by a series of causation: ultimately, disease must cease and health be resumed by the efficient causation, so many times described; but medicines do not commonly operate in this way, they lead up to these results.

§ 9. Curative medicines may be divided into three classes: 1st, those that cure by a direct relation with the cause of disease; 2nd, those which cure by removing or obviating a perceptible (or sensible) cause of disease by an intermediate relation; 3rd, those which cure by latent causation. First, to exemplify these.

1. It is possible that a cause of disease may be removed in a direct way, that is, the artificial means may be related with the perceptible cause of disease, without any intermediate relation: as if a remedy should be found, which being taken into the circulation is chymically related with gall-stone so as to dissolve it, thereby curing jaundice (supposing it to arise from an obstruction of this sort in the biliary duct); or, as if a fluid should mix with indurated fæces, soften them, and so admit a natural evacuation of them; or, as if a solvent should be discovered for calculus in the kidneys or bladder. The cure of diseases in this way, by medicine, is similar to that of the cure of diseases by the operations of surgery: thus, by lithotomy a stone is removed from the bladder, and the disease which its presence produced ceases; thus amputation is performed above a diseased joint, and the hectic state of the constitution, which was produced or maintained by the local disease, ceases; or, the bursting of an aneurism is prevented by intercepting the supply of blood by a ligature, &c. But the instances of the direct relation of an artificial means with the cause of disease, in medicine, are rare.

2. Recurring to an example, jaundice, we will say, is produced by obstruction of the biliary ducts; under the exhibition of mercury, this obstruction is removed, and the jaundice is cured. We will say, for the sake of a specification, the cause of the disease is a gall-stone. There is no *direct* relation between the mercury and the gall-stone, by which the latter may be removed; the gall-stone would not be removed by putting calomel or blue pill into the stomach, or into the gall-duct of a dead man. Mercury, then, removes the gall-stone by its relation with some of the properties of life, in some or other of its seats: say that mercury quickens the action of the heart, and increases the impetus of the circulation, and that thus mechanically, by a vis a tergo, the obstruction is removed: the relation then of the mercury is with the heart; if any other modus operandi is assigned, then the mercury removes the gall-stone by another *intermediate relation*. Disorder of the stomach is produced by the presence of bile: this is removed by an emetic, and

the disorder ceases; the relation of the emetic is with certain properties belonging to the structures, which, in conjunction with it, produce the state necessary to the act of vomiting; by this action the bile is ejected. Disorder, dependent upon the presence of indurated fæces in the colon, is cured by purgatives; the relation of the purgatives is with the secerning function of the internal coat of the intestines, perhaps also with the mesenteric absorbents, and with the properties concerned in the peristaltic motions of the intestines. The indurated fæces are removed from the colon, as a consequence of the state produced by this mediate relation.

3. The remedies belonging to the third class are the most numerous, and it is upon these that we rely (and the grounds of this reliance will come to be examined) in all cases in which the efficient cause is not known. To exemplify this class of medicines which cure by latent causation: a disorder of the head may be cured by repeated bleedings, local or general; long before the period at which the disorder ceases, there may be much less blood than is compatible with perfect health; that is, the disease continues when the quantity of blood in the system is considerably less than at a former period of health; bleeding then in this case does not cure by removing a sensible cause of disease. A fever may be cured by bleedings, purgatives, antimony, &c.: we do not know the cause of fever, or if we can assign any cause it may be a remote one, which has ceased to operate, such as cold; the phenomena of fever are produced by a modified state of the principle of life; who can say in what this modification consists? or, what cause (supposing the state to be produced by some foreign properties) is removed by the remedies? or, supposing the state to consist of deficient causes, what properties, or whether any existing in the remedies, are the identical ones which the spirit requires in order to have its state of health restored? An herpetic eruption on the skin may be cured by arsenic: who can specify the causation among the properties engaged in these processes of the subversion of disease, and the restoration of health? Not to be tedious in enumerating instances, we may briefly say, that the precise causation by which remedies cure diseases is never known, or is latent, except in those instances where the cause which produces disease is a sensible one, or in which we infer a sensible cause from analogy. These exceptions belong most frequently to that class of remedies which cure diseases by an intermediate relation, examples of which are specified under that class. Inflammation, as pneumonia, is diminished by agents which reduce the action of the heart, and diminish the volume of the circulating fluids: the means which produce these effects are blood-letting, which is perhaps directly related with the action of the heart, and this action mediately with the state of inflammation; purgatives, which are related with the properties of the intestines, and again mediately with the state of inflammation; to which may be added such medicines as nitre, ipecacuanha, emetic tartar, squill, digitalis, &c. These means do not remove a supernumerary, or supply a

deficient cause: they are employed without any reference to the cause of disease, either sensible or inferred. The causation of remedies which is insensible or imperceptible, and which is not to be inferred by rules of analogy, may be expressed as latent. To extend a little our consideration of these classes respectively.

1. The known examples of agents which produce effects by direct relation with the cause of disease are few, and are chiefly confined to the means of operative surgery. It is, however, possible that some medicines may operate in this way insensibly, or where the cause of disease is not suspected, and where the properties contained in the remedy and corrective of this cause, are not known. In order, however, to restore health, the assimilating healthy state of life must be restored, which is seldom or never the case with palliatives, forming chiefly the class of medicines here hinted to operate in the direct manner; as a violent pain in the bowels may be suspended by a dose of laudanum; but the pain will perhaps return, which would not be the case if the laudanum restored health by the direct causation which produces in every respect the state of health. The laudanum only produces a change in the condition of the disease, the result of which is the mitigation of pain, &c. The remedies which are known to cure by removing the cause of disease are related not with *primary*, but with secondary, or the effects of primary disease.

2. Medicines that remove the cause of disease by intermediate relations. These remedies are mediately related with the consequences of primitive disease, and cure the diseases dependent upon the re-action of these consequences, or the continuance of such causes. Thus mercury, by merely quickening the circulation (to specify a possible mode), may remove biliary obstruction, and the phenomena would cease which are dependent upon such obstruction: thus also purgatives remove worms, the presence of which may have occasioned epilepsy; but neither the biliary obstruction nor the worms would have been formed without that previous change of the state of health, which we have called predisposition. The jaundice ceases and the epilepsy ceases, because an agent is employed which mediately removes the causes upon which these remote consequences of primitive disease depend. The remedies of this class may cure primary disease; but this does not happen by the removal of a known cause, simply for the reason that the cause belonging to the properties of life is not to be known.

3. Remedies which cure by latent causation. Remedies which operate in this way do it by directly supplying or removing unknown properties, &c. or by accomplishing this end indirectly, or by mediate relations. They rarely, if ever, accomplish this work of restoration *directly*, as above remarked. We infer this from the fact that the state of health does not immediately succeed the exhibition of the remedy, which it should do if this remedy directly removed or supplied a property which was differential in comparison with health. The only answer which can be made to this remark is,

that remedies of this kind, curing by repeated doses, the direct causation might obtain, and yet the state of health not be immediately restored because the quantity was deficient. This answer is, however, invalidated by the additional fact, that if the quantity is increased, so far from improving the effect, it may produce death, as arsenic, for example, which nevertheless cures by a repetition of small doses. The perceptible effect, also, of most remedies of this kind is to produce a state different from health: they cannot therefore on this account be admitted to operate in the direct way. The inference is therefore warranted, that medicines which operate by latent causation, do it by a process the result of which is attained by intermediate relations.

§ 10. The subdivisions of the third class, or of remedies which operate by latent causation, are, 1st, those that cure without a sensible operation; 2nd, medicines that produce cure by sensible change, or by sensible effects; 3rd, medicines that cure by employment upon the seats of disease, with or without sensible effects; 4th, medicines that cure by an operation upon *related seats*, with or without sensible effects. To speak now more particularly of the relation which each of these classes has with the condition of disease.

1st, Medicines that operate without sensible effects. In this manner arsenic may cure intermittent fever, scorbutic disease, &c. In this way diseases are cured by bark, by antimony, and mercury, in small doses, &c. The cure in these instances is accomplished by successive causation, and consequently the relation of the remedy with the condition of the disease is mediate.

2nd, Medicines that cure, producing sensible effects or disorder of their own. The remedies which fall under this class are by far the most numerous: to this class belong all the emetic and purgative medicines, arsenic and mercury, in large or frequent doses, antimony, steel, henbane, hemlock, digitalis, blisters, bleeding, issues, &c. These remedies also operate by successive or intermediate causation, without removing, in the cases we are supposing, known causes.

3rd, Medicines that cure by employment upon the seats of the disease. In this way all those remedies act which are applied to individual seats through the medium of the circulation. In this way, also, the topical remedies act, such as cupping, lotions, blisters, &c. These operate by mediate relations; and in the cases we are supposing, that is, where the precise cause of disease is not ascertainable, by a train, or succession of latent processes of causation.

4th, Medicines that cure by an employment upon related seats. Thus, a disorder of the head is cured by emetics, or anasarca of the legs by purgatives; or a disorder of the head existing beneath the cranium, by the actual cautery to the scalp; or a disease of the eye, by an issue in the arm or a seton in the back of the neck; or as a disorder of the stomach is cured by purgatives, or an inflammation of the pleura by blistering the skin; or as a disease of a joint is cured by a caustic issue, &c. These remedies act also by successive

causation, or by a series of related processes. I am not conscious of any medical agent that ever has been employed, or that can be employed, with any view, or any mode of operation, which is not included in one or other of the preceding divisions. We have now to consider something of the laws which regulate the results of the operation of those remedies, concerning which we have no further experience than that they are capable of affecting the condition of disease, by intermediate or related processes.

1. Primary disease in all instances consists in a change, or modification of the principle of life, compared with the state of health.

2. Primary disease is a state of the principle of life compatible with its assimilation; and in this way it is maintained.

3. Secondary disease may be maintained after primary disease has ceased.

4. Secondary, or rather consecutive disease, may be maintained in two ways after the primary disease has ceased: 1st, if such is the relation between the life of different seats, the influence of the primary upon the secondary may be to produce a modified assimilating state of it, as if a swelled testicle should follow the irritation of an injection, and degenerate into schirrus, long after the urethra has resumed its state of perfect health; 2nd, the consecutive disease may be maintained by an effect of the primary, which does not arise out of a direct relation between vital properties, as when primary disease changes the textures or the secretions, or produces foreign substances, &c. The consecutive disease of the spirit may then be maintained by these causes, and these causes being removed, it ceases, because the relation of their properties with the spirit is not to produce a modified *assimilating* state of it. These causes, or *effects of primary disease*, may be distinguished as the *material occasional causes.*

5. But primary disease may maintain consecutive disease by direct relation of the properties of the principle; and this secondary state continuing only so long as the primary lasts, the properties producing the secondary disease may be distinguished from those producing a modified assimilating state, as the *occasional spiritual* causes of disease: as when the respiratory organs are disordered by pressure upon the brain, as by bone, and resume their natural state of properties when this pressure is removed.

6. Every disorder of the spirit which is not maintained by the occasional material causes, is maintained by assimilation: for if the disorder should be of the secondary kind, and does not assimilate in its seat, it is dependent upon a disorder which assimilates in some other seat, the present sum or quantum of the spirit requiring to be perpetually renewed, and acknowledging no other source than that of assimilation.

7. Remedies operate either by removing a known cause or by latent causation. It is an object in medical investigation to discover the cause of disease; for though every internal cause which we are capable of knowing must be a consequence of previous disease, being

once formed, its existence may be independent of that primary, or previous disease which produced it. In such a case the only present condition of *spiritual* disease may be that dependent upon a *material* occasional cause, which being removed the existing spiritual disease ceases; as when by the operations of surgery (to advert to palpable instances) the material effects of previous diseased actions, as they are called, are removed, febrile or other consecutive constitutional disease, engaging properties of the spirit and maintained by such occasional material causes, ceases.

8. But most remedies operate by latent causation, or by successive causation. The operation of remedies may in this way acknowledge a complication equal to that which has been described of disease. The relation of remedies may be *directly* with unknown material occasional causes, or *indirectly* with such causes; or, in a few instances, directly with the state of primary disease; or, more frequently, indirectly with the state of primary disease; or with secondary assimilating disease, directly or indirectly; or directly, or indirectly with secondary occasional disease.

9. Those diseases are the most numerous in which no cause, as of the material occasional kind, can be assigned. We are not justified, in these instances, in inferring the existence of such cause by general analogy, or merely for the reason that diseases are sometimes known to be maintained by the material occasional causes, since disease must *originate independently* of such causes in every instance, and since the instances in which such causes are ascertainable are comparatively few. When, therefore, a cause of this sort can neither be known sensibly, nor assigned in agreement with any *particular analogies*, we are justified in concluding only that the modified phenomena which depend upon spiritual agency are produced by a state of disease which consists of a modification of the healthy state of the spirit. Conformably with this rule, we should infer all diseases of function, which are not dependent upon the material occasional causes, to consist in a modification of the properties of the spirit.

10. As all diseases of the spirit are maintained by assimilation, it remains that we should consider the agency of remedies, with respect to that process by which disease is maintained.

§ 11. A relation subsists between the spirit and certain external causes, the result of which is, that the state of the former may be modified or changed by the agency of the latter.

§ 12. The properties of the external causes are related with the spirit either directly or indirectly: directly, as when effects are produced exclusively by the combination of the properties of external causes with those of the spirit; indirectly, as when the state of the spirit is changed by the operation of external causes upon the alliances of the spirit, as upon the fluids or the organized substances. These are possible modes of the operation of external causes upon the spirit. It is in no case possible to demonstrate when the primary relation of externals is with the spirit, and when with its

alliances, seeing that both are in all instances at the same time exposed to their operation. If, however, the relation of remedies were in every case with the material or fluid alliances, it would not interfere with our conclusions on the laws of the operation of remedies on the spirit: the only difference would be, that, instead of producing such and such effects directly, the same would be produced *mediately*. But as it can rarely be proved that the change of the spirit is a result of a change of its alliances, and as the change of the spirit itself is in every instance to be inferred from the change of phenomena dependent upon it (which change is the only proof of a causative relation of any kind, in most instances), so it is best, having stated these possibilities, together with the alternatives to which the argument would be liable, supposing them to obtain, to speak of the operation of remedies in general as influencing directly the principle of life, without which influence, the changes which occur in the material or chymical alliances are no more than would result from the same causes employed upon the dead subject.

§ 13. Every change in the organic spirit is according to its relation with the cause that produces it. But different agents will sometimes agree in producing similar effects: thus, a disorder which might be cured by blood-letting may also be cured by purgatives, or by emetics, blisters, &c. In other instances, particular diseases, or states of the principle, are cured only by some particular means; as certain forms of syphilis by mercury, the itch by sulphur, scurvy by arsenic, &c. The effect which is produced in common by the former means can be identified only by the same causes; we have then to determine whether they possess common efficient causes, disguised by different alliances? or whether they have only the force of remote causes to which a series of processes succeed, the result of which, through different relations, may be finally to identify the state of health?

§ 14. We have thought it necessary, on grounds before stated, to conclude that remedies never restore *health* on the direct principle of causation, viz. that of supplying deficient properties, &c.; at least, remedies can never be employed with this view, except in the instances of the material occasional causes, of which those that fall within the department of medicine are very few, and with which the direct relation of remedies is perhaps altogether problematical; our alternatives are therefore briefly answered: remedies must on this account, with respect to the cure of diseases, have always the force and operation of *remote causes*.

§ 15. The manner in which external agents produce change in the condition of the spirit, in the direct way which we are now considering, is by an alliance of their properties with those of life, by which the combinations of the constituent properties of life are modified, and hence exhibit modified phenomena, which are commonly expressed in symptoms.

§ 16. The identity which life assimilates is dependent upon the combinations of its integral properties: its phenomena also depend

upon these combinations. The state of life is in general pretty un form, but in instances which have been remarked in our physiology, properties before latent are developed, as in the case of puberty, and still life assimilates.

§ 17. A change of the combination of constituent properties produces the phenomena of disease: life assimilates under this state; and as long as this assimilation continues, the state of disease is maintained.

§ 18. But progressive causation may be going on among these constituent properties, the result of which, in the state of disease, *must be either to exhibit other symptoms in a series, or a return to the former assimilating state of health, or a termination in death.*

§ 19. One particular agent may have such a relation with the existing diseased state of life, as to determine its series of processes towards the restoration of health. This depends upon the relations of integral properties with the agent, and their relations with each other, under the modifications produced by the agent. To this class of agents belong the specifics, mercury, sulphur, and all single remedies for a disease.

§ 20. But many remedies may have the property of restoring health by a common relation; as when the existing state of the principle is a diseased one, which will continue, if left to itself, to assimilate in this state, and hence, as long as this state continues disease may in this way be maintained: but this state may be changed or superseded by a variety of agents, by any which have a causative relation with it; *to produce a change is a common effect of many agents*, and this change having taken place, the further series of combinations is determined by the relations of constituent properties, which obtain under *this new state.* The tendency under *any state* is either to a return to the previous state of disease, when the operation of the agent has ceased, or to additional symptoms which might be called a deterioration of disease, or to recovery, or death. *Hence, as every remedy must be productive of one or other of these events, so these events must respectively have a common relation with many remedies.*

§ 21. *Particular* remedies, or *specifics*, produce a state under which exclusively the relations of integral properties with the new state of the principle, or the remedial change, is to terminate their series of processes in the recovery of health.

§ 22. *General* remedies agree in producing a change of the existing state of the principle, and the result of the change is liable to the four alternatives just specified.

§ 23. General remedies may produce a change in the seat of the diseased principle, either by an operation upon this seat, or by an agency upon a related seat: thus, disorder of the head may be cured by bleeding from the temporal artery, by long-continued purgeing, or by nauseating doses of antimony, &c. or by an issue, perhaps, in the leg. They have the common property of changing the existing state of disease, which would maintain itself by assimilation, or of

modifying a tendency to deterioration of disease, supposing such tendency should exist: and the final result of the change is then governed by relations among constituent spiritual properties, all of which are latent.

§ 24. We here perceive an agreement between the operation of general remedies and the results of substituted disease. Thus, a man may have inflammation of the liver; this may cease upon the occurrence of phrenitis, and this may cease upon the occurrence of profuse discharge of blood from the rectum. This series is related in curative order; but in another case, as in those cases cited of *extended* disease, the secondary may have no curative relation with the primary disease.

§ 25. There is, as just remarked, some analogy between those instances of spontaneous cure by substituted disease and the operation of general remedies: thus, the spontaneous termination of nervous disorder, pain in the head, &c. may be in an attack of cholera. A similar termination may perhaps be artificially produced by agents which also occasion vomiting and purging. A disorder of the head may be cured spontaneously by an abscess: if we were called upon to treat artificially the same disease, we should perhaps employ a caustic issue, or a perpetual blister, &c. The point of analogy is, that in both instances primary disease ceases, under the occurrence of secondary.

§ 26. But there appears a certainty in the curative result of spontaneous secondary disease, which does not always obtain when we attempt to imitate it by artificial means: thus insanity may be cured by a spontaneous abscess of the back, but we should be disappointed in another case, if we were to expect a cure by making a caustic issue in the back, in a situation corresponding with that of the abscess; thus, also, a primary disease, in which purgatives have failed totally, may be cured by a spontaneous diarrhœa. We shall be at no loss to reconcile this diversity of result, when we recollect that substituted spontaneous disease cures, either because precise or identical properties of the primary disease pass to the secondary seat; or because independent disease, established in the secondary seat, must in all the examples of substituted disease (taking the succession as a proof of causation) have a curative relation with the state of primary disease: on the other hand, artificial disorder may fail for want of agreement in these respects; that is, 1st, because the properties of the primary disease may remain in their seat notwithstanding a relation with a new disease, which only modifies their phenomena in some respects; and, 2nd, because there may be no relation between the seat of artificial affection and that of primary disease. If there is a relation, and this is not of the curative kind, then remedies which disorder, instead of imitating the substituted, exemplify the extended disease.

§ 27. The preceding sketch exhibits a history of the general nature and cure of diseases. If it is desired to trace more minutely the laws of disease and the operation of remedies, it may be done,

pursuing the clews here suggested, to a considerable extent, when the investigation is employed exclusively upon one object. We know nothing of the efficient causation of diseases: we reason upon this causation on grounds of analogy; but the causes concerned can never be specified, because they are not objects cognizable to the senses. We aspire occasionally to the removal of remote causes, as when we take blood from a vein, or remove a stone from the bladder, but in these cases, the latter of which is the least equivocal, we are ignorant of the efficient or real cause: a stone in the bladder, it may be said, is the cause of irritation; remove this stone, and the cause is removed, and the irritation ceases; very true: the cause is removed with the stone, but what is the cause? The effect of the stone is to produce a certain state, which we call one of irritation of animal properties; these properties can be modified only by an union or combination of other properties: it would be absurd to say that *a stone combined* with life, and modified its identity. The efficient cause must be looked for in the properties of the stone, which are related with life; what these properties are we cannot define, because they, like the properties with which they are related, are not cognizable to the senses. Indeed, in this case the distinction remains to be drawn and the grounds of it stated, whether the relation of the properties of the stone is direct or mediate; whether by latent properties common to matter related with life (such as are indicated by food, or nutritious substances), to be classed neither as chymical nor mechanical; or whether by simple gravity modified in its agency by shape and asperities, and related with the spirit by means only of a primitive relation with the mechanical structures, with which the spirit is in alliance. It suffices, however, in these cases, without looking for true or efficient causes, that we are enabled to remove these causes by our knowledge of their alliance with sensible substances.

§ 28. The sum of our experience (or, perhaps more correctly, of our information, for it is mostly inferential), is,

1st, That some remedies will cure some diseases, and that others will not.

2nd, That the employment of remedies is founded upon analogy; that is, such diseases have been cured by such remedies, and, in agreement with the analogy, we employ the same remedies when we meet with the same diseases. The practice of medicine upon this principle has been called empirical. The difference between empirical practice and that which is distinguished as scientific is, that the analogy in the first is general, and in the latter it is particular. The empiric founds his practice on a partial observance of the analogy of symptoms, and on the general results of remedies; the man of science does not employ remedies simply because they have been found to cure, but he employs them with a view to a particular mode of operation. The empiric would give a purgative where disease was accompanied by long-accustomed torpor of the bowels: the man of science would perhaps give a purgative in the same case,

in order to remove scybala, upon which he infers the disease to depend: one practises from the curative result, the other with a view to causes; one gives the purgative upon the general analogy that such symptoms have been so cured, the other gives it on the particular analogy that in resembling cases scybala have been found in the bowels, upon the removal of which the disease has ceased; one is a loose, and the other is a minute observer. They have respectively their disadvantages: the empiric may fail by overlooking the particular analogy, which may be of principal importance; the man of science may fail also, by an erroneous inference with respect to the cause; a thing which happens every day, and nine times out of ten, when we presume to assign *a cause*, where the agents of the processes are not objects of the senses.

§ 29. It may be asked, what advantages then has the man of science over the empiric? Where is the difference, whether the same remedy be given with a particular design, the result of minute observation, or whether it be given upon the general principle that such a remedy has been found by experience to be curative? To this I reply, as the same result would generally be attained in either case, so in general the loose, and the observing practitioner would ply their art with equal advantages. But the empiric may sometimes push a treatment, when the man of science would suspend it; or, *vice versa*, the empiric would say, I have tried this remedy which used to succeed, it has failed and I will abandon it: the man of science would say, in the same case, this remedy which has hitherto failed must be continued, or its doses increased, because it has not yet produced *that particular effect upon which I have observed the restoration of health to depend.* The chief advantages of the observer are, that he has ascertained the dependence, or laws of the disease, and he directs his means according to his knowledge of these laws, rather than from a vague expectation of a final result, to be accomplished he knows not how.

§ 30. If we would define this matter with greater precision, we may say, the use of observation in medicine is to extend our knowledge of the *particulars* of the several states of disease, by which we might be enabled to say, in a comparison of cases, in these respects they agree, in these they differ; and direct or modify our practice according to the circumstances of analogy or diversity.

§ 31. A remedy is employed for the cure of a disease, with a view to the removal of a cause, either known or inferred. Nothing is more common than for men to practise with this design; but the instances in which the cause is known, are indeed very few, and those in which a cause is inferred are mostly erroneous or equivocal. This has been shewn in our preceding pages, where one says disorder of the liver is the common or universal cause of disease, another says the same of the stomach, another of the excitability, &c.; all this is fanciful: in these cases a cause has been inferred, without analytical inquiry. We know that we remove a cause of vomiting and constipation when we set free a

portion of strangulated intestine, or we know that we remove a cause of extended disease when we remove a stone from the bladder, or amputate a diseased limb. These causes are unequivocal: but in medicine, with a few admissible instances, the rest are for the most part conjectural and assumed. At the same time, it must be allowed that to keep in view the discovery of the cause of a disease, is always an object worthy emulation, since the success of our practice is never so certain as when, with adequate means, it is directed to the removal of a known cause.

§ 32. When a remedy is employed without any view to the removal of a cause, known or inferred, we must confess that it operates by a latent causation, or by a process, with the agents of which we are not acquainted. But although the cause is not known, we may observe a remedy is curative which produces certain effects; and we infer a dependence of the cure upon such effects: for example, we know that mercury will cure syphilis; but observation has instructed us that mercury will not cure syphilis unless it produce certain constitutional effects. We know that disorders of the head or eyes may be cured by antimony; but it is the business of observation to point out the terms upon which antimony will cure these disorders. Their terms of cure, we otherwise call dependences. In case of disease, in which there is analogy of symptoms, we infer analogy of dependence; and hence we employ the same remedies, upon the expectation of a similar dependence of cure, in different diseases. Particular indications of treatment are founded upon precise analogies; general indications, upon analogies which are general, only because they have a partial resemblance.

§ 33. Diseases have a general resemblance in this respect, viz. that if they are not maintained by the material occasional causes (which are those we aspire to remove) they are maintained by assimilation: this is a general point of agreement in the nature of disease. The corresponding general agreement in the operation of remedies is, that *the present assimilating state must be interrupted before health is restored.* Many agents must inevitably agree in this effect; and we are therefore furnished with a general indication of cure, upon which we might presume, in the absence of a particular one. The agents which agree in this effect are numerous, we employ them upon analogy; and this analogy also may be general or particular: general, as we find that most remedies which produce sensible effects will influence the condition of disease; particular, as when it has been ascertained that *some* remedies will influence the condition of disease, and that others will not. In the treatment of diseases upon a general principle, or in all cases in which the operation of remedies is not to remove known causes, the result of the modification they produce in the state of disease is dependent upon the relations of constituent properties of the spirit, under the artificial state produced by remedies, and it is to the chances of these relations that we

trust leading up to the events of recovery, extended disease, or death.

§ 34. But we observe that the general tendency under preternatural affection is to the recovery of health: this has given rise to the "vis medicatrix naturæ," which is produced by the same properties naturally as those which determine the same event under preternatural circumstances. It is by the series of causation which constitutes this tendency, that health is invariably restored, under the operation of remedies which cure by indirect processes. The immediate effect of remedies is to produce disease: if health arises out of this disease, the properties which determine it are not those of the external, whose invariable property is to produce disease, but those which decide latent causation in a series, the termination of which is in health.

§ 35. A *particular indication* of treatment is to remove a known cause by a known remedy; or, when the cause is not known, to employ a particular agent, which has been found in a sufficient number of instances to be curative, without our being able to assign the manner how, in a disease identified by such symptoms: particular indications are founded upon precise analogies. A *general indication* of treatment is to employ remedies which have been found to succeed in cases analogous in some respects. The chief object of medical inquiry is to obtain a particular, in exchange for a general indication of treatment (and hence the chief advantage of a methodical nosology, by which diseases are classed according to their resemblance); whether with regard to that particular indication which is founded on a knowledge of causes, or to that tendency, which is ascertained, in a sufficient number of instances, to determine the processes of causation towards the recovery of health. The attainment of this object is the business of observation: when this object is not attained, or perhaps attainable from defect of experience, or defect of faculties, the treatment must be conducted according to the general indication, the next object of which is, by increasing the knowledge of facts, to multiply or improve the points of analogy. When the indication of cure is no further particular, than that it directs *a change* in the existing state of disease, we are left to select our remedies from our experience of those which in general accomplish most effectually this end; and, conformably with our experience, in the absence of specific remedies, and remedies directed to remove known causes, the method of changing the condition of disease, with a view before explained the most frequently successful, is by the repeated employment of purgative, emetic or nauseating medicines, or by bleedings, issues, &c.; these succeed in this end because their relations are general, or their operation is upon seats which are the centres of many sympathies.

§ 36. It has been observed that the cure of a disease requires the continuance of remedies which affect or change its condition, and this change is indicated completely to have taken place only

by the cessation of the symptoms of the disease. It is a point of nice discrimination, to decide how far remedies are to be urged when the condition of disease appears to be subverted, so as on the one hand to subvert also the tendency among constituents, which first produced it (or in other words to prevent a relapse); and, on the other, to avoid the danger of deteriorated disease, which may end in death, by the processes which succeed to the continued employment of the remedy. This matter is exemplified familiarly in syphilis; and the point of discrimination is to administer enough mercury to cure venereal without producing mercurial disease: the same or a greater nicety of discrimination is required in the treatment of many chronic diseases. For the purpurposes of this distinction we must trust to our experience in particular cures; as if squill and calomel should cure a dropsy, which will return when the medicine is left off, we must consult our experience in order to judge what continuance of the preternatural, or remedial affection is sufficient, not only to remove the present symptoms, but to subvert that tendency to dropsy which first produced it, and may produce it again; or how long the remedy must be employed to produce a totally new *predisposition:* our experience also in these cases must be consulted, in order to decide how far, under certain states of constitution, remedies may be pushed, with this view of subverting diseased tendencies, without risking the substitution of a new, and perhaps a worse disease.

§ 37. To repeat: the basis of every treatment is the analogy of disease, and the experience of the results of remedies. We say experience of the analogy of disease, and experience of the effects of remedies; but our *experience* in these respects is imperfect or equivocal. If we were capable of experiencing the similitude of diseases we should never be mistaken in their character; but we often are mistaken. We may experience a resemblance in certain symptoms, but different latent causes may be associated with a similar exhibition of certain symptoms; these causes are developed in the progress of disease, and then we confess the inadequacy of our experience. In strict truth, this which we call an experience of the similitude of diseases is only an inference, or in part an inference: we infer a similitude of the entire state of disease from a sensible analogy in some circumstances. So also with respect to our experience of the effects of remedies: we experience only the succession of events; and disease frequently ceasing from latent, spontaneous processes of causation, under the exhibition of remedies, we infer that the remedies produce the cure because the recovery of health succeeded to their employment. Hence it is that so many remedies have obtained credit for curing diseases, which, upon further trial, have been found to possess no such power. There is only one way (rarely practicable) of guarding against error in making these conclusions, and that is, not to admit succession as the proof of causation, until the succession by its frequency approaches to the *invariable*, upon which analogy an

inference of causation may be allowed, in the manner and with the exceptions before more fully explained.

This analysis of the nature and cure of diseases has been attempted in conformity with those doctrines of causation, the application of which has been said to be universal. It is impossible to make a view so complex, embracing so many topics, appear simple, and at first sight intelligible. I have traced the processes of nature in this sketch, with a minuteness which on untried ground can scarcely be exceeded. Nature is said by some to be very simple in her operations: she is simple enough to one who contemplates things in the gross; whose sum of philosophy consists in stating results, without troubling himself about the machinery by which they are accomplished. If this analysis of disease should be reproached as obscure, I say the obscurity belongs to the subject. I wish it had been possible to make it clearer: but if the same objects should be attempted by one who would make this obscurity a reproach, he would find it difficult to give *a readily intelligible* account of them, though this subject alone should be drawn out to the length of a respectable volume.

SECTION V.

DEATH OF THE ORGANIC LIFE.

CHAP. I.—*Death in Connexion with Disease.*

§ 1. BY the term "death" is implied a cessation of the phenomena which characterize the state of life. It has been said that life is distinguished by its preserving the cohesion of the structures. This is to some extent true; yet we cannot estimate the continuance of life by the preservation of the structures, for their integrity remains many days after death. We must then enumerate some other of the phenomena of life, by the cessation of which the state of death might be distinguished. Without waiting for the dissolution of the textures, we may say that death has happened when respiration has ceased, and when the action of the heart has ceased; when the blood, no longer in motion, has coagulated in the heart and in its vessels; and when the temperature of the body is reduced to that of the medium by which it is surrounded. It will scarcely be imagined that a man is not dead when these things have taken place. Life is a state of properties which produces phenomena before enumerated, and readily agreed upon: death is a state of properties incapable of producing any of those phenomena characteristic of life.

§ 2. In a case, as of sudden, death, all the properties which accomplished the phenomena of life still inhere with the subject, or are involved in his structures: the change is one of combination, by which an elementary or separated state, has succeeded to the formal state, of the properties which identified life. In what the change consists we cannot specify; nor can we say with what substances or properties those of life are related at the period of this change, because our senses are not qualified to take cogni-

ance of such objects: the most that we can do is to reason upon this change on rules of analogy, which, if these rules are universal, as has been assumed on physical proof of those of causation, are entitled to the same reliance in this, as in other subjects of inference.

§ 3. Death happens either

1st, From defect or modification of those causes which maintain life, and which have been sketched in our physiology; or,

2nd, From the operation of certain related externals.

§ 4. Of the causes which maintain life, the first to be spoken of are those which constitute the living spirit. All that we can say of these causes is, that in one particular state they produce the phenomena of life and health; that if this state is modified, they produce the phenomena of disease; that a further, or other modification of them is followed by death. We have seen, in the article on Disease, that the *origin* of every spontaneous modification of the living state is in the properties of life. The spirit is constituted by many properties, among which subsist certain relations: from the relations between these properties, changes take place in their combinations, which are progressively continued, or suspended, and renewed, by the operation of an external, or maintained by consecutive effects, as those of the material occasional causes, of disease; or maintained by spiritual assimilation, &c. As the first modification of the healthy spirit might originate from relations in its own properties, so it is probable that the progression might be continued in this spiritual department, until the identity of it is so far changed, as to be incapable of assimilating a state of properties productive of the phenomena of life. But, in general, death is preceded by changes in the material alliances of life, which might contribute more or less essentially towards this event. The case which comes nearest to exemplify the occurrence of death, by the exclusive change of the spiritual state, is perhaps furnished in some of the forms of mortification incident to old people; where death suddenly happens in a part while it is still supplied with the same arterial blood as other parts, and where the textures are not perceptibly more impaired.

§ 5. Three conditions are required for the maintenance of life in every seat: 1st, a healthy state of the principle of life; 2nd, the integrity and fitness of the structures; 3rd, an adequate and correct supply of well-formed arterial blood. As long as these conditions are observed the state of life is maintained, and it continues until one or all of these conditions are infringed.

§ 6. Death commonly happens through the medium of disease: when death takes place suddenly and spontaneously, without previous disease, the difference is, that whereas in disease the changes preparatory to death are indicated by symptoms; in death, without disease, the preparatory changes do not produce symptoms, or they are latent; in which latter case, death follows predisposition.

§ 7. Disease and death agree in being modified states of life: but the state of disease is still productive of the phenomena of life;

the principle assimilates, though a modified identity: the state of death is one in which these phenomena cease, and cannot be renewed; this is the result of the series of changes which are at first latent, or in the state of predisposition, then exhibiting symptoms, or constituting disease; then a further change being attained, the state is that of death.

§ 8. The history of disease is the history of death, up to that point of the series in which the final change of disease into death takes place. We can no more say, why predisposition should become disease, than why disease should lapse into the state of death. They are catenated processes of causation, the agents of which are not objects of the senses.

§ 9. The history of death begins with the history of disease. The origin of disease has been said to be in latent properties of the spirit, which determine that course of changes indicated in our sketch of the nature of progressive causation. Accordingly, our divisions of the modes of disease will furnish those of death, or will exhibit the modes by which the conditions of life, just mentioned, are infringed. The *origin* of the spontaneous processes, which terminate in death, is in the spirit: but death may take place in a seat either,

1. From primary, or,
2. From secondary, disease.

§ 10. Death happens from primary disease when changes take place in the properties of the spirit belonging to the seat of death, whether local or universal, the termination of which processes is in an unassimilating state of life, without the influence either of a modified state of the spirit in another seat, or of a modified condition of the blood or structures.

§ 11. Death happens from secondary disease, either directly or indirectly: directly, as when the relation of a disease or of death in a primary seat is, by the intercourse of vital properties, to impair, and finally destroy, the assimilating life of a secondary seat; indirectly, as when the relation which should subsist between the life of a seat and its fluid and structural alliances, its material products, is impaired or wholly frustrated by the changes which the quantity or constituents of these alliances have undergone, by the previous operation of disease, either in the seat of death, or in one which thus, indirectly, comes to be related with it.

§ 12. 1. Death happening from primary disease exclusively, is an occurrence, the possibility of which is conformable with our general principles; but our experience of death furnishes us but one apparent instance in which the existence of secondary disease is not perceptible: that instance, before cited, is one of mortification: as when, without previous pain or inflammation, a black spot may appear upon some part of an extremity, perhaps it may be discovered accidentally (this has happened); this spot is found to have lost its sensibility, to have lost its characteristics of life. From such a beginning the mortification spreads; and it *appears*

to spread, as if the principle of life in this seat spontaneously became extinct, and as if the structure of the part suffered no change save that which might be imputed to the extinction of the living principle. This is the only case which occurs to me, arising out of our experience, in which death may be attributed to exclusive change in the life of a seat, terminating in the cessation of this principle; and even this case is not unexceptionable. It may be argued against, by observing that latent preparatory changes might have been going on in the structure of the blood-vessels of the part. It will be observed, that their phenomena are not those of a mere extinction of life, with preservation of a healthy state of the organization: life, it will be urged, becomes universally extinct in every instance of death, yet we do not find that the whole body immediately assumes the appearance presented by a gangrenous state of the structures. The mortification also, it will be observed, is a sloughing process; no such process supervenes to death in other instances: half the integument of a foot may slough away in three or four days, while the integrity of the same textures may be preserved, in ordinary death, perhaps for weeks. Hence it would appear, that if a long series of preparatory processes did not take place in the structures of the blood-vessels previous to death, these structures were peculiarly influenced by the agency of life, previous to its extinction. It would remain to discriminate whether such changes of the textures were merely the effects of a tendency of the principle, which run its course of disease, independently, to its final extinction; or whether its tendency to extinction was affected, or in part produced, by the re-agency of the condition of the structures: under these doubts, we must say that we have no unequivocal example of death by exclusive changes among the properties of life; that such a mode of death is indicated by some of the phenomena of mortification: at the same time, that the possibility of such a mode of death is conformable with general principles.

§ 13. Thus much may be said modestly, and with strict respect to the evidence. But, it must be remarked also, in favour of this mode of death (by exclusive spiritual causation), that although, in the instances in which it might be supposed, it is not impossible but the event may be assisted by the re-agency of a preternatural condition of the fluid or structural alliances; yet, on the other hand, it can rarely be proved, where these secondary states of the materials are the most obvious, that they help in any degree the extinction of the spirit; or that this latter does not run its own course of change, independently of such supposed re-agents. Thus, for example, suppose death to happen by phrenitis: the secondary material effects of the primary conditions of the spirit are turgescence of the blood-vessels, the effusion of patches of lymph, perhaps rather more serum in the ventricles than ought to be found in them, &c. I would ask what is the proof that these secondary diseases, these material changes, contributed to the

extinction of life? or what is the proof that the spiritual change which began, may not proceed by that progressive causation described, independently, to the termination of the series in death? What is the proof that these perceptible phenomena were re-agents, or in turn *causes* of change, to the spirit, rather than mere accompaniments? There is no positive proof, the state of phrenitis never takes place without these phenomena; but because a modified condition of life necessarily produces these effects, it is not to be concluded that these effects become causes, and in turn help to produce the extinction of life, until the existence of such a relation is made clear on other grounds. Such a relation, or something approaching to it, is indicated: we know that, in inflammation, the throbbing of the pain corresponds with the systoles of the heart; and hence we conclude that the circulation may re-act upon a similar state of disease: and we know that pressure upon the brain will kill (though in fact this happens indirectly) where there is no previous disease; and hence we conclude that effusion into the ventricles may be a cause of death in phrenitis, as when the symptoms of this disease are exchanged for those of apoplexy. But because we have proofs that the impulse of blood into inflamed vessels will produce pain, and that distention, under certain diseased states, will increase pain, and that pressure upon the brain will kill; it does not follow, when these things happen as effects of other previous and progressive disease, but that the finale of this progression, viz. death, might take place without their assistance; which is further proved by the fact, that a disease of the brain of long standing, sometimes producing convulsions, and finally delirium, and coma, followed by death, has not been found on dissection to have been accompanied with *perceptible* disease; on the contrary, the *structure* of the brain has appeared natural, *and its vessels preternaturally free from blood.* If it were worth while to push further a discussion which was designed to shew only the manner in which our inference of death by primary disease is capable of being considered and supported, it may be remarked, that the re-agency of the circulation upon disease, on the evidence just cited, is founded upon an assumed extension of analogy. We experience that pain is increased, as in whitlow, at each systole of the heart; this experience of ours respects a relation between the circulation and sensibility, and we assume a similar relation with respect to the organic life. This is a mere assumption: if it were investigated perhaps, the assumption would be confirmed on other evidence; there is no reason, *a priori*, why the organic life should be disturbed in an inflamed seat by the fulness of its vessels, or by the systole of the heart, unless such reason should be furnished by a physiology which shews that such disturbance might take place in consequence of the natural relation subsisting between the quantity and the properties of the blood, and a defined state of the textures, and the organic spirit. It is not necessary to pursue this matter further at present, we may hereafter

have some other topics which may require to be connected with the considerations here hinted at.

§ 14. Death is either local or universal: mortification and ulceration both, exemplify local death. Universal death is never known to take place, unless there is a seat of death in a functional organ, whether originating, or produced secondarily, in such organ. The organic life of a functional organ is commonly made to cease by the impairment of the function (in which case the death of the organ is produced in a way common to every other part), and not by the primary extinction of its own organic life. Not however to anticipate the order we have proposed, we must proceed to illustrate our other mode of death, viz. by secondary disease.

§ 15. 2. Secondary disease produces death, directly or indirectly: directly, as by relations of spiritual properties; indirectly, as by the changes of the material alliances in the seat of death.

§ 16. Death produced directly by secondary disease is of two kinds: 1st, when the secondary seat of disease (or death) holds with respect to the primary a relation of the regular dependent kind; 2nd, when a new relation is opened between the spiritual properties of seats, by disturbance or change of these properties in one of them, where no previous natural relation subsisted.

§ 17. The first class is illustrated in all those organs to which a dependence has been assigned. Thus a disease, or injury which impaired or destroyed the life of the brain, would produce secondary death of the lungs; because the influence of the brain, dependent upon a healthy (or certain) state of its life, is necessary to respiration. Thus also, if an influence from the brain or spinal marrow is necessary to the life of the heart, the death of the heart would succeed to a certain disturbance or destruction of the life of the brain or spinal marrow; and the death of a secondary seat would happen in consequence of the same relation, in any other case in which such relation can be proved to exist.

§ 18. The second class, or those cases in which secondary death is directly produced by primary disease, in seats having no natural dependent relation, is exemplified the most unequivocally in cases of injury, and frequently enough in cases of spontaneous disease. Thus the *irritation* (for the sake of a name) produced by a fractured leg may be extended to the heart, and raise its actions to 140 in a minute; this happens from direct relation between vital properties: finally, the heart in consequence of such injury, may cease to act at all. In this case a new relation is opened where there was before no regular dependence, except that common one for the supply of arterial blood; for the whole leg might be cut off, and the heart will not die, which it would do, if there were any relation of dependence. To the same class belong most of the examples of the sympathies, in which, as before sufficiently insisted upon, secondary is produced by primary disease, and consequent death, in seats holding no natural relation.

§ 19. I have applied the term " death," in these cases, in compliance with common language. When the heart ceases to act, this has been called the death of the heart; the same of the brain, when the phenomena of life and health, which are imputed to it, no longer occur; and the same of the lungs, when respiration ceases. I would be understood (for it is a point of doctrine of importance) that these are not instances of the causation of death of the organic life, but of suspension, or extinction of function; producing consecutively, by a relation common to all parts, the death of the organic life. Death, or extinction of the organic assimilating life, in one seat, can never produce directly death of the organic life in another; for the organic life, as has been satisfactorily proved, is every where dependent only upon its own existence, and upon the supply of blood. Hence, if one leg were to die, the organic life on one side the line of mortification would not be at all affected by the death of the leg, provided it were itself a correct assimilating principle, and was supplied with arterial blood. The sympathies of disease in the organic life may lead to processes of causation in related seats, which may terminate in death, in such secondary seats: but this would happen from *communication* of the same properties, whether life were afterwards preserved or extinct, in the primary seat; for relations of life cease, when the change of life into death has happened; and as no phenomena can then be produced by relation of the primary with a secondary seat, except loss of function in the cases of that which has been called regular dependent life, so it follows that the organic life of one seat cannot suffer by the death of the organic life of another, since the organic life is never dependent for the constitution of its principle upon another seat, but lives by assimilation.

§ 20. Hence, death of the organic life in one seat never produces death of the organic life of another directly; but it may produce loss of function directly, as in the instances mentioned: as, if the brain should die, respiration would cease, because respiration is dependent upon the life of the brain; or, if the spinal marrow should die (if this is a true relation of the kind), the action of the heart would cease; but such death of a primary seat, producing, first, loss of function in a secondary seat, directly, and then universal death indirectly, produces universal death, or death of the organic life, by the relation which functions have with the formation or circulation of the blood, upon which the existence of the assimilating life in every sphere depends.

§ 21. Death is, as before remarked, produced by secondary *disease*, directly; and the modes of death, according to causation here, are the same as the modes of the extinction of function, viz. by addition or subtraction of properties: as the properties are not objects of the senses, we cannot determine by analysis which of these modes obtains in the several examples. But, in agreement with a loose rule of analogy, before proposed, we should be inclined to infer, that death happens by privation of properties, where it succeeds

in a secondary, to death of a primary seat, between which there subsisted a natural relation of dependence; and that the mode was that of addition of properties, in cases of secondary disease, terminating in death, produced directly by primary disease in seats which acknowledged no natural dependent relation.

§ 22. Those effects of primary disease which consist in modification, or preternatural formation of substances, allied or related with the principle of life, produce local death in or near the seat of such effects, either by direct relation with the life of such seat, as when a disease of a bone, perhaps a dead portion of a bone, produces or maintains ulceration (which is one kind of death) of the contiguous parts, or by the influence of such effects upon the circulation, as when a tumour, together with the adjoining substances, sloughs from an interrupted supply of blood, caused by the pressure of a foreign growth; or as when, by long processes of disease, extreme vessels give way, and the life of the part becomes extinct, because the circulation has ceased. The examples which fall under this class are not very numerous.

§ 23. Secondary indirect disease produces universal death by influence upon the blood and circulation, upon which the existence of the diffused spirit depends. Secondary, indirect, disease operates by this medium in two ways: 1st, by producing secondary direct disease, which to produce death is commonly related with a functional organ, upon which life depends, and upon which life depends in no other way than by the importance of this function with respect to the blood; 2nd, by preventing the adequate supply of blood to the whole system, with or without any mediate relation, with a function or organ, subservient to the formation and circulation of the blood.

§ 24. The first is illustrated in the cases of death produced by occasional material disease; as when death takes place from irritation, as from that of a stone in the kidney, a diseased bone, &c.; in these cases, these material effects of primary disease affect, impair, and finally destroy the action of some functional organ, as of the heart, in consequence of which universal death succeeds.

§ 25. The second is exemplified when death happens from the pressure of a tumour upon the trachea, or when death is produced by spontaneous hemorrhage, as by the bursting of an axillary, or iliac aneurism.

§ 26. This classification includes nearly all the possible modes of local, or universal death, according to the relations before sketched. The inference, that disease in one seat produces universal death by relation with a functional organ, which organ is related with diffused life through the medium of the blood, is founded upon the fact that a local disease never produces death until the functions connected with the blood have ceased to be performed. In other words, all the processes of organic life, as the spiritual assimilation, the secretions, &c. do not cease until the heart has ceased to

circulate blood. The spirit may be universally modified by the same original disease, as that which finally produces death; and this modification is expressed in the changes of its phenomena, or in symptoms: but the functions subservient to organic life by their relation with the blood, are first impaired, and cease; and then the diffused assimilating life becomes extinct. This is the usual order, with but few exceptions, which belong to the examples of secondary direct disease by communicated properties, possibly terminating their progressive causation in death.

CHAP. II.—*Death produced by External Causes.*

§ 1. THE modes by which external agents (comprised chiefly in poisons and mechanical injuries) produce death are included in those which have been assigned as the modes of disease. The difference is, that whereas the origin of death by disease is in progressive causation, predisposition, &c.; the *origin* of death by externals is to be considered at the period of their exhibition or infliction. It belongs to specific inquiry to trace the particular relations of the several poisons in the mineral, vegetable, and animal departments. The phenomena of external injuries, also, inasmuch as they differ from those of spontaneous disease, form the subject of a specific analysis. But the general conformity of both with the preceding modes and divisions may be briefly shewn.

§ 2. Poisons either destroy life by properties directly related with the principle, so as to render it, by their combination, an unassimilating identity; or else their relation with the diffused organic spirit is not direct, but the vitality of this spirit is destroyed by their agency through the medium of a primary influence upon the properties engaged in a function, or upon the material alliances. These are the modes of the operation of poisons, which, it will be seen, are those of disease, and concerning which therefore it no more belongs to this place to be particular than to trace the history and varieties, respectively, of every disease which may terminate in death.

§ 3. Injuries of the mechanical kind, from external causes, may produce either local or universal death. The phenomena in these cases are also reducible to the classes which have been assigned to those of disease. Injuries producing universal death are commonly inflicted upon a functional organ, when death immediately succeeds to such injuries, as upon the brain, heart, spinal marrow, lungs, or great blood-vessels, &c. In these cases, such injuries kill by impairing or destroying the function of the organ on which they are inflicted, or of one holding with it a natural relation of the dependent kind. But injuries sometimes produce speedily universal death, which are inflicted upon seats which are not necessary to the life of the rest of the body; or, if

necessary, are not so immediately essential but that life may for a time be preserved without them. Thus, a severe injury of a leg may produce death in twenty-four hours, and a wound of the stomach or bowels may produce death in the same time: in the former case, death is produced by injury of a part which has no function upon which the life of the system depends; in the latter case, the injury takes place in an organ which has a function necessary to life; but the exercise of this function, viz. digestion, may be suspended several days without occasioning death. The consecutive processes which follow these injuries are merely additional instances of secondary disease, terminating in death.

§ 4. The only question or difficulty which I feel disposed to suggest, with respect to mechanical injuries, is concerning the mode in which they produce the phenomena *assignable only to spiritual change.* We find that the point of a needle applied to the skin with a slight pressure, so as not to penetrate the skin, produces pain: we find that a bullet going through the brain will immediately destroy its function, as a consequence of which universal death succeeds. And we observe with respect to these phenomena that any mechanical agent, which produces the same mechanical effect upon the structure, will produce the same effect upon the properties of life. Hence, the relation is not with any peculiar properties belonging to the instrument which inflicts the injury, but with the effect of the injury, or with the condition of the textures, &c. which the injury has produced, and the capability to produce which may be common to many agents, very different in their general character. To reduce the question, we will ask why the life of a part suffers any change not imputable to loss of blood, from a mere solution of continuity in the structures, as by the thrust of a small-sword?

§ 5. The palpable effect of such injury is to separate parts which were before united, in consequence of which inflammation, with its accompaniments, pain, increased heat, &c. supervene. The first effect is a mechanical separation of a structure before united; the subsequent phenomena are those which can be produced only by spiritual change. It is obvious that the spirit, or the imperceptible properties allied with the structures, would suffer no change by the passage of a small-sword through the sphere in which they exist, any more than the air or the still grosser fluid, water; unless indeed the agent possessed properties related with the spirit, which may affect it independently of the mechanical injury, which, for the reason above assigned, is not the case. The only conditions of the maintenance of the identity of the living principle are, the existence of this principle, and the presence of blood. Now the principle lives in the separated surfaces, and in them may be supplied with blood. If then the principle suffers that change which constitutes one of disease, it suffers this change from one of three effects of the infliction of the injury.

1st, The spirit residing in these surfaces receives a modified supply of blood, as by the general injury, the compression, &c. which the vessels must sustain by a breach in a structure before continuous; or,

2nd, The mechanical change of the structure must directly produce a change in the condition of the spirit; or,

3rd, The spirit is directly modified by the confusion, or mixture of spiritual properties, which before held distinct spheres.

1. It is probable that the disordered circulation, necessary to a surface produced by mechanical separation, may (as the circulation is every where so intimately connected with life) contribute to produce that change of the spirit upon which the consecutive phenomena of the injury depend.

2. It has been shewn in the chapter, " Relations between Vital and Mechanical Properties," that a mechanical agent can have no direct relation with life. Hence, we can assign no agency in these phenomena to mere mechanical influence, except that mediate one implied in our 1st and 3rd alternatives.

3. The sphere of life in every seat is maintained by the alliance of the spiritual properties with the organic particles of such seat. Hence, if the organic particles are disturbed or displaced, the spiritual properties suffer a corresponding disturbance, and those which should occupy distinct spheres become mixed. Of the tendency of spiritual properties of one seat to modify those of another, we have seen enough in the preceding pages. The modes in which such modification may be produced in the present instances are, 1st, by direct change in the life of the separated surface, by union with heterogeneous properties; 2nd, by indirect change, by disturbed relation between the life and the nutrient material of such seat.

§ 6. According to the nearest and most frequent analogies, I should say that mechanical injuries produce their effects upon the principle of life, commonly, by the confusion of the life which should hold distinct spheres, in consequence of its alliance with the matter which is disturbed merely by a mechanical relation; and by the change which life suffers by mechanical injury of blood-vessels, the state of which life depending upon a regulated supply of blood, suffers also a change, in agreement with the preternatural relation thus mechanically occasioned. From the suddenness with which life is affected by mechanical injuries, it appears as if the spirit suffered most commonly in the way described, without the intermediate relation of a disordered circulation, as in cases of wounds, and more especially those happening in the brain, spinal marrow, or nerves. Indeed, from some of these instances, a pretty unequivocal argument might be deduced in favour of this mode of the effects of mechanical injuries; but it is sufficient to have suggested these modes, and to add, that by these modes a state is established which produces further effects, by processes, generally analogous to those of spontaneous disease.

CHAP. III.—*General Nature of Death of the Organic Life.*

§ 1. WE have spoken in our preceding sections of the manner in which the spirit lives; in this, we have hitherto considered the mode by which it dies: there is only one further stage in in its history, viz. to say, if we can, what becomes of this spirit, our old acquaintance, after it is dead?

§ 2. The question of what becomes of life at the time of death? is answered by saying, what becomes of it during life: for the spirit is perpetually dying: it lives by assimilation, or is maintained by succession, or by a perpetual renovation from its elements; the life which exists at one point of time, resembles, but is not identically the life which existed in a preceding minute. Life exists, and immediately changes its form, enduring no longer than while it unites its own elements from earth and air, existing in the nutrient material with which it is related. Life is, renews itself, and dies. If the life which is present could support a fixed or permanent state, the function which supplies it with air, as a supporter of life, might be suspended, and the living form be still preserved; and the same of the other supporter, containing elements from the earth, viz. food, which might also be withheld: for a principle which is not perpetually passing away, requires no supporters for its perpetual renovation.

§ 3. One difference between death of the spirit, during the continuance of life, and its final death, is, that the spirit during the living state repeats itself from its elements, before it dies: final death happens from defect of such repetition. Another difference is, that in final death the spirit, previous to its extinction, is commonly rendered a modified identity by disease, which is not the identity it preserves when it repeats itself from its elements. This difference may affect the fate of the properties of life in the two instances, disposing them to different relations; but we cannot say in what respects their fates, respectively, may on this account be affected. But this difference does not obtain in the cases of final death, from sudden defect of a supporter of life, as in cases of death by hanging, drowning, hemorrhage, &c. in which examples the spirit was well disposed to assimilate a healthy identity which

fails from defect of its constituents, which should be furnished by the material.

§ 4. According to this account, life exists first informally in food and in air; food is converted by the preparatory organs into blood, which receives from the lungs the addition of air; still life exists in blood, as in the earth and air, *informally*, though it is in this state prepared for the operation of another agent: this agent is life; so that life exists in blood informally, its elements are then united by life, and then it becomes informal again. Our present question is, what becomes of it?

§ 5. It is obvious that, in reply to this question, we cannot cite proofs. We have said that life no sooner is, than it becomes informal: we must suppose either that it becomes informal, or that it escapes from its sphere in every seat, and, preserving its form, exists as life in the atmosphere; if it retains its sphere in the textures, then it is necessary that its form must be changed, it would otherwise continue to produce its phenomena, and would not require the means of renovation. That life may escape from the body and preserve its form, is a proposition which cannot be refuted; at the same time, we are not obliged to refute it, because no argument can be cited for its support. The grossest absurdities which imagination can suggest frequently do not admit of refutation; we scarcely think ourselves bound to prove them false: we are excused the attempt at refutation in every case in which the proposition is supported neither by experience nor by analogy. But if the life of an animal should preserve its form after escaping from the body, it is of very little use; at least, we can have no idea of its use or agency, for it is not capable of the phenomena of life which are distinguished or identified only by their relation with the body; and, therefore, in regard to the phenomena of the living state, it may as well be informal. The properties of small-pox may exist in the atmosphere without being allied with matter, and preserve their animal form. If the properties of the spirit of a man did the same, they would neither of them be capable of their characteristic phenomena, *which are relative:* the former, with animals disposed for their operation; the latter, with substances also necessary to the effects by which alone their existence can be inferred. If it be said that an organic spirit, or any spiritual form, may perpetuate its influence by alliance with new animal textures, by a sort of metempsychosis; it may be answered, it is not likely that it should either form structures for itself from elementary materials, or ally itself with structures previously formed, seeing that its palpable tendency was to separate from the organized fabric with which it was actually allied, and in connexion with which it was assimilated. That life, during the living state, which is the same in this respect as the dead, passes away from the body still preserving its form, appears to be a proposition without proof, and consequently is not to be considered; and that life, becoming informal, then escapes from the textures, is equally without proof. There remains, then, only one other alterna-

tive, viz. that life, becoming informal, allies itself with the textures, and suffers changes, in agreement with relations in which the textures or their constituents are concerned.

§ 6. If any arguments may be cited in favour of this proposition, they also will be short of proof, although we may perhaps say, that the proposition is indicated by the following considerations: 1st, elementary life has a natural relation or affinity with the material of the structure; it exists in a state of combination in the blood, and requires nothing less than the operation of formal life to dissolve this union; 2nd, the structures of every animal are found to contain elementary life, and furnish it to plants, and to other animals. Upon the first of these considerations chiefly, we may say, it is indicated that life, when it becomes informal, unites with the organic substances and materials from which it was first produced, and among which it lived. Presuming, then, upon this alternative, merely as one which has been said to be indicated, or which is perhaps better supported than any other, the processes of the formation and extinction of life may be thus described. Life existing formally, pervading the structures, unites its own elements, which exist informally in the nutrient material. The life thus formed cannot endure: and as its change or extinction cannot happen from its own causes, which must be those of constitution (except indeed by an internal causation of which there are no proofs), so it is necessary that the conversion of the living spirit into informal life must happen by relation with some causes existing in its sphere. These causes can be no other than those belonging to the material which life pervades; and the decomposition of the living, into the informal spirit, happens by this agency, which must be one of affinity: this circumstance furnishes additional grounds of indication, that the informal life still resides with the material fabric; which it must do, unless additional acts of causation take place, of which we are wholly destitute of proofs.

§ 7. But although the structures of one animal will maintain the life of another, they will not maintain the life of the animal to which they belong. In other words, an animal may die in four or five days for want of food, although all the life which has been consumed in that time still resides with his structures. The death of an animal, under these circumstances, may happen from a deficiency of blood, which is a consequence of starvation; and this deficiency may, it is said, be related with the extinction of life, either in respect to the quantity or the quality of the blood. A sufficient quantity of blood has been supposed necessary, in order to preserve a certain distension, an *orgasm*, as it is phrased by those who substitute words for meaning, a mechanical fitness, &c. Without disputing the general efficacy of this orgasm, or mechanical distention, &c. it is sufficient to remark, that starvation does not produce death in this way; for the quantity of blood made in four days is not equal to 80 ounces, which may be lost by a man within 24 hours, and his life be nevertheless preserved. We must then adopt the other al-

ternative, and say that an animal dies from starvation in the same way as for want of air, viz. by the privation of a supporter of life, by defect of elementary life, with however this difference, that a larger sum of the elements of life from earth, compared with their consumption, exist in the blood than of those from air; and consequently an animal will, for a considerable time, sustain the privation of food, but requires incessantly the renewal of atmospherical air. But our present question is, how happens it that an animal dies from defect of the external supporters of life (seeing that they are only elementary till life makes them formal), when elementary or informal life must every where abound; and existing in the spheres, is subject to the operation, of the living principle?

§ 8. The reason why the living principle does convert elementary into formal life in one instance, and not in another, is, that the informal life of the blood is fitted for the relation with the formal life which assimilates it, by the series of processes performed by the preparatory organs; and the life which was elementary in the blood, having become formal, again becomes elementary in consequence of its holding a new relation with surrounding agents; and with *this informal state* of life the living spirit does not hold, as in the case of that residing in the blood, the relation by which it is assimilated. The only terms upon which the life which has been formal, and has become elementary, can again be converted into life are that the new combinations of it should be superseded by the influence of preparatory organs, and that it should again be reduced to the state of it in respect to the living spirit, in which it existed in blood. So perfect is the adaptation of the preparatory organs to the living principle, that no animal can be supported by means of nutrition which have not passed through the organs subservient to this end; and although animals of every variety and species, and perhaps vegetables, also, may be fed with a common material, yet each, from the agreement between the preparatory functions and the living principle, takes only those constituents which make up his own identity, and hence the uniformity of their several characters is preserved.

§ 9. We observe that the organic substances of one animal furnish to the life of another those elements only which are derived from the earth. In other words, the supply of external air is just as necessary to the life of an animal whose food consists of the organic substances which have before been the seat of animal life, as to that of one whose food consists of vegetables. If, then, the life which has become informal in one animal helps to constitute the life of another, the elements from earth are adopted for this purpose, while those of air (which must also exist in the same substances) are obtained from without. This is a circumstance which may be urged in objection to the theory which supposes that life, becoming informal, passes into the surrounding substances, and again contributes to identify the life of another animal, into which these substances might pass. But this objection may be obviated or ren-

dered questionable, by the possible relations of the preparatory organs, which may be to separate from food particles which contain only one elementary part of life; and the relation may be with a certain quantum of these elements, leaving the excrementitious matter still possessed of elementary life; while the other part of elementary life, viz. that derived from air, not being related with the preparatory organs, follows the fate of its other combinations; and consequently these elements, not being received as constituents of blood, require to be furnished from the atmosphere. It must be confessed, that on these relations we can at best speculate but loosely; and their suggestion is rather with a view to future investigations, than intended, upon such weak evidence, to challenge belief.

§ 10. The state of death is an informal state of life: certain properties concurred as causes to constitute the living state; as long as the relations of these causes are uninterrupted, the living state is preserved. But there is a tendency in these causes, with the help of externals, to interrupt or change their relations; their concurrence to form the living state no longer obtains; and the properties which before formed life are engaged in new alliances, and contribute to produce new phenomena, in connexion with the new existences with which a new relation is opened. We cannot trace minutely the further history of the respective causes which once made the living state. We can only observe generally of them, that the constitutents of the living body of one animal in time revert to something like the state of life which has already been broken upon. The remains of an animal are either taken as food by another, and then by a short process contribute to the composition of such other animal;* or else they are consigned to the earth, where they perhaps again contribute to animal life, working here darkly, or remaining at rest, held by the force of existing relations, and in the lapse of ages, perhaps by some accident come again to play a part in the sensible world; or they pass through a vegetable form, and from this are perhaps again assimilated by animals. Whether there are instances of decomposition so complete, that the causes which have once supported animal life are wholly indisposed to enter into this state again, or contribute to it in any shape; whether they can form alliances which no possible change in the relations of the world may dissolve; is a question not easily settled, and the affirmative of which it is scarcely consistent with analogy to suppose.

§ 11. We observe that the remains of animals are consigned to the earth, perhaps many feet below its surface; here they supply or originate other forms of life. The animals thus produced live

* This is the only possible mode of spiritual translation: and, according to it, the identity of the spirit of a dead animal is not preserved; for as the animal receiving such properties lives by *assimilation*, so the translated spiritual properties are only *causes which concur* to maintain a *previous nature*, no more of them being engaged than are necessary to this end.

in a situation which excludes the atmospheric air, or at least the animals from whom they are derived could not exist in such a situation, for want of air. Is it that there are animals who are capable of separating from the remains of others the elements both of earth and air which have passed into their organization, when life became informal; or is it that a scanty proportion of air penetrates deep into the earth, and suffices to afford the elements obtained from this source, necessary to such forms of life? This latter solution will be preferred, though it is not free from a contradiction, which it is hardly worth while to state.

§ 12. So far as we are capable of observing, one law appears universal in the translation of life and organic particles, viz. that if the causes of the living state of one animal live again in another, they live, not according to their own nature, but according to that of the new animal which they help to form, and which preserves his identity under any variety of the means of nutrition, provided they are to him means of nutrition; that is, he takes out of them only himself.

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FINIS.

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ERRATA.

Page	Line	
9,	4,	for not, read now.
52,	2,	for methink, read methinks.
56,	28,	read from "or" to "inference," line 29, in a parenthesis.
56,	35,	for these, read there
72,	36,	for entric, read entire.
91,	16,	for parieties, read parietes.
95,	30,	read *as* are all other growths,&c.
101,	20,	for parts, read poets.
102,	8,	for contended, read contented.
139,	13,	for recollection, read memory.
143,	17,	read from "he" to "that," line 20, in a parenthesis.
149,	44,	for ovum, read ova.
155,	37,	read *with* those precisely formed, &c.
160,	40,	for these, read them.
165,	31,	omit comma; to be placed at through.
167,	17,	omit second comma.
177,	19,	for is, read it.
178,	25,	for effect, read effects.
179,	7,	for our, read due.
186,	35,	for latter, read natural.
199,	2,	omit in.
214,	3,	omit but.
216,	19,	for distension, read distention.
222,	4,	for independently, read independent.
232,	34,	for material, read matter.
239,	28,	for particles, read particle.
259,	12,	for is, read are.
269,	26,	for the, read an.
280,	17,	for infections, read infectious.
285,	44,	for these, read this.
285,	44,	for functions, read function.
312,	46,	for seaton, read seton.
316,	46,	for purgeing, read purging.
317,	45,	for irritating, read imitating.
341,	27,	for upon, read up.